No 2682 VOLUME 78 FRIDAY 5 AUGUST 1960

FLIGHT

AIRCRAFT, SPACECRAFT, MISSILES

Official Organ of the Royal Aero Club First Aeronautical Weekly in the World Founded 1909

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Iliffe & Sons Ltd, Dorset House, Stamford Street, London SE1; telephone Waterloo 3333. Telegrams Flightpres Sedist London. Annual subscriptions: Home £4 15s. Overseas £5. Canada and USA $15.00. Second Class Mail privileges authorized at New York, NY.

Branch Offices Coventry: 8-10 Corporation Street; telephone Coventry 25210. Birmingham: King Edward House, New Street, 2; telephone Midland 7191. Manchester: 260 Deansgate, 3; telephone Blackfriars 4412 or Deansgate 3595. Glasgow: 62 Buchanan Street, C.1; telephone Central 1265-6.

New York, NY: Thomas Skinner & Co (Publishers) Ltd, 111 Broadway, 6; telephone Digby 9-1197.

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The New Men . . .

THE architect of Britain's new aircraft industry, and of our new civil aviation structure, moves on to fresh fields. At a stroke of the Prime Minister's pen, a new man takes Mr Duncan Sandys' place as Minister of Aviation.

The changes that Mr Sandys wrought during his nine short months in office were revolutionary. His departure is disconcerting, to say the least. The faster the turnover in Ministers, the greater becomes the power of bureaucracy: the executive tends to take charge of the legislature, and Ministries' accountability to Parliament tends to diminish.

This general trend in our public life—which is worrying so many MPs—is potentially very strong in the case of the Aviation Ministry. We quote from a recent issue of *The Log*, journal of the British Air Line Pilots Association:

"He [the Minister of Aviation] is placing himself in direct control of almost every aspect of the aviation industry: specifications, orders, purchases, operating, safety, licensing, accident investigation, the lot. Mr Sandys may well be competent to cope with all this, but what of his successor? If the whole structure of aviation is built upon Sandys, when he shifts we may find ourselves on the rocks."

What of Mr Sandys' successor? Let the able Mr Peter Thorneycroft be given his chance; but let it not be forgotten that the aircraft industry bowed to the will of Mr Sandys largely as an act of faith in his person—in particular in his undertakings in respect of Government support not only for the new civil projects (a bargain that has been kept), but support also for the prodigies of space and supersonic airliner technology that the industry is eager to get started on. The inheritor of these undertakings, the man who will now have to fight the Chancellor for massive investment in British aviation technology, is a former Chancellor himself, and one who resigned on the point of principle that the nation was trying to run far too many expensive projects. Mr Thorneycroft was Chancellor at the time of the BEA jet controversy; he was never notably predisposed towards public investment in British aviation. One very senior industry executive, we recall, told us in February 1958—just after Mr Thorneycroft resigned—that the ex-Chancellor had seemed to think that we would be better off were we to import more of our aviation products from America. We sincerely hope that Mr Thorneycroft was being misrepresented.

. . . and the Licensing Board

There were other disconcerting appointments last week. Only one of the six new members of the Air Transport Licensing Board, Mr A. H. Wilson, has had real experience of air transport (see page 196).

When, last February, *Flight* suggested names for this Board, we expressed the hope that its members would be not merely "men of judgment," but men doing a "job they really know something about." Again, on February 26, we qualified our remarks about the limited power of the new Board by suggesting that at least "much will depend on the men on the Board"—who we hoped would be "a team of professional air transport people."

Our hopes have not been realized. Frank Beswick has been passed by, so has J. J. Taylor, one of the most respected members of the Air Transport Advisory Council. It is incomprehensible that, so far as we have been able to ascertain, neither of these men has been asked to join the new Board.

But at least they will have over them a man of whom we said six months ago: "We can think of no better chairman than Lord Terrington whose diplomacy, knowledge of the law, and understanding of the essentials of air transport are universally respected."

FROM ALL QUARTERS

Aviation's New Minister

FROM the Cabinet reshuffle which took place last week aviation gains a new Minister, Mr Peter Thorneycroft succeeding Mr Duncan Sandys (who becomes Secretary of State for Commonwealth Relations) as Minister of Aviation (see previous page).

Mr Thorneycroft

Mr Thorneycroft, who is 51 years of age, resigned the post of Chancellor of the Exchequer in January 1958, following Cabinet disagreements on Government expenditure. Educated at Eton and the Royal Military Academy, he served in the Royal Artillery from 1930 to 1933, subsequently studying for the law and being called to the Bar in 1935. He was Conservative MP for Stafford from 1938 to 1945 and Parliamentary Secretary, Ministry of War Transport, 1945. He was President of the Board of Trade from 1951 to 1957. At a by-election in 1945 he was elected MP for Monmouth, and retained his seat at the 1955 and 1959 General Elections.

New British Light Aircraft?

REPORTED last week was the interest of Mr Peter Masefield, former managing director of Bristol Aircraft, in a British executive aircraft. The design, presumably related to the project abandoned by Bristol Aircraft at the time of their merger into BAC, is said to be capable of challenging latest American executive types on price and performance. The project would not be linked with either of the major aircraft groups but might be supported by the industry. A British light aircraft is Mr Masefield's personal crusade, and he is attempting to form a team, with himself as chief executive, to get construction under way.

Hovercraft Plans

THE hovercraft industry is quickly getting into its stride. Last week preliminary news was released of the plans of Hawker Siddeley (recently rumoured as being an entrant to the field) and William Denny & Bros Ltd (named a month ago as being at work on a vehicle).

Both are collaborating with Hovercraft Development Ltd, subsidiary of the NRDC. No facts are yet available about the type of craft Hawker Siddeley have designed, but it is understood that construction will be by Folland Aircraft. Denny, long famous as shipbuilders, are to concentrate on a side-wall type of craft, the sides of which remain partly under the water surface; forward and aft the air cushion is bounded by an air curtain. In effect it is an air-lubricated ship, and in comparison with existing hovercraft it requires less power to maintain the air cushion; on the other hand, it is perforce a marine craft rather than an amphibian.

Mr Dennis Hennessey, chairman of Hovercraft Development Ltd, said last week "the total programme in which we are interested now contains four projects for different kinds of hovercraft . . . All the companies concerned, including Hovercraft Development Ltd, are discussing their common problems with a view to establishing among themselves an agreed policy regarding the future development of hovercraft."

The projects to which Mr Hennessey referred are, in addition to the two mentioned above, those of Westland Aircraft (Saunders-Roe Division) and Vickers-Armstrongs (South Marston). Some details of the SR-N2 plans were given in *Flight* for July 1.

Under development independently of these vehicles is the Britten-Norman Cushioncraft, which has already been airborne, though tethered in compliance with ARB requirements; a description and cutaway drawing appeared in *Flight* for June 24.

The original Hovercraft—the Saunders-Roe SR-N1—made its first public appearances at Cowes in June last year, then when it crossed the English Channel, and later when it was demonstrated at the Farnborough Show.

Richard Fairey

ONLY two months after we announced the retirement, on medical advice, of Mr Richard Fairey from the vice-chairmanship of Fairey Aviation, we have the unhappy duty of recording his death, which occurred at Cannes, in the South of France, on Thursday of last week. Whilst on holiday there he had been in the care of an American heart specialist. He was 43 years of age.

Elder son of the late Sir Richard Fairey, he entered his father's firm in 1936, working in the jig and tool office and subsequently transferring to the design office. During the war he served in Air Transport Auxiliary. In 1941, while he was on his way by sea to the USA to join the Atlantic Ferry Organization his ship was torpedoed and he spent five days in an open boat, suffering frostbite which culminated in the amputation of both legs. Within eight months, while still convalescent, he was serving as a technical officer at the A&AEE, Boscombe Down. After the war he rejoined the Fairey Company and was appointed works manager of its Weybridge factories. Later he held appointments as general manager and as a director, being appointed vice-chairman in November 1956.

Dick Fairey gallantly refused to allow his disability to hamper his flying. He qualified on four-engined aircraft and jets, and flew a helicopter solo after only 1hr 45min of dual instruction; soon he was using helicopters as executive aircraft. He also flew a D.H. Rapide and other fixed-wing aircraft many thousand miles at home and abroad, particularly in Canada and Australia, on the company's business. His log-book eventually showed some 6,000 hours' flying.

The funeral took place at Cannes last Friday. Mr Fairey leaves a widow and two-year-old daughter, and a son by a former marriage.

The Victor B.2 Search

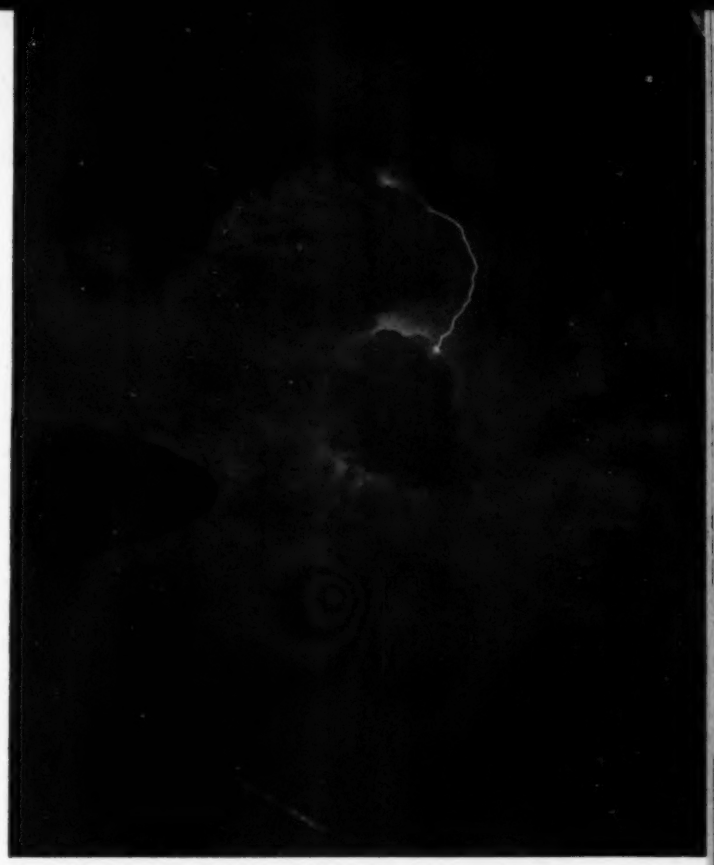
AN interim statement by the Admiralty last week on the salvage operations—still proceeding—for the Victor B.2 lost off the Pembrokeshire coast last August disclosed that no fewer than 150,000 fragments of wreckage—about 50 per cent of the aircraft—had so far been recovered. Eleven trawlers, charterd by the Admiralty on behalf of the MoA, were engaged, and so far the search had cost £1½m. It was hoped that over 90 per cent of the wreckage would ultimately be recovered.

As soon as they were landed by the trawlers, the fragments—ranging from scraps of half-crown size to pieces weighing several hundredweight—were taken to RAE Farnborough, where investigators were "putting together the mammoth jigsaw puzzle." It may be assumed that the eventual success of the Elba Comet salvage operation has been a big factor in the authorities' determination to carry the present search to a decisive conclusion.

More Rocket-boosted Mirage IIICs

THE Armée de l'Air originally planned to use only some of its Marcel Dassault Mirage IIICs with SEPR rocket engine for the intercepter role. Now, so successful have been the service trials of the pre-production aircraft at the Centre d'Essais Militaire Européen at Mont-de-Marsan that the number is to be increased considerably. The improved high-altitude performance, particularly in respect of manœuvrability, is reported to have been fully up to expectation and to have confirmed the Air Force in its dual-power policy. An additional order for Mirage fighters is expected to be placed quite soon.

***OILSINK** is the name of a Danish composition which, it is believed, could prevent oil pollution of beaches. It is seen being sprayed from a Lancashire Aircraft Prospector during a demonstration at Oakhanger, Hampshire, last week*



STORM OVER ITALY: This "lucky shot" of lightning—it is so described by Mr John Stroud, who took it—was secured at last light from a Misrair Comet 4C flying at 34,000ft north of Rome

TSR.2 Questions

ASKED in the House of Commons on July 27 by Mr Rankin (Lab, Glasgow Govan) whether the Air Minister had been authorized to go ahead with production of the TSR.2, or if he proposed to adopt the NA.39 instead, Mr W. J. Taylor (Under-Secretary of State for Air) said there had been no change in the status of the TSR.2. Development was proceeding, but the stage had not yet been reached when a production order was needed.

In answer to the second part of the question Mr Taylor referred to an answer given in 1959. On Mr Rankin pressing the subject further he said:—

"The NA.39 is a fully developed aircraft now and is in production. When the matter of the TSR.2 was being examined we looked at the possibility of having a stretched version of the NA.39 instead of ordering an entirely new aircraft to meet the new operational requirements. The question of time-scale also arose. There has been no significant change in any of the operational factors which led the Government to the decision to proceed with the TSR.2."

Asked by Mr Wall (Con, Haltemprice) whether it was not a fact that the Canberra was already obsolete for low-level flying, and that the NA.39 adapted to ground take-off could be in service in half the time it would take to produce a new aircraft, Mr Taylor replied:—

"The Canberra will remain effective for a number of years. To replace it we need an aircraft with a greatly improved performance capable of penetrating strong defences during a long operational life. Developing it should not take much longer than adapting the NA.39 to overland operations in all weathers. To develop a new aircraft will be more economical, because the aircraft will last longer."

IFR Certificate for Cessna Helicopter

AMERICA'S Federal Aviation Agency has issued its first certificate for operation of a helicopter under instrument-flight rules. The aircraft so approved is the four-seat Cessna CH-1C, which for the past two years has been undergoing intensive development trials with a control system claimed to afford stability comparable with that of a fixed-wing aircraft; this is achieved without the aid of electronic equipment. Powerplant is a Continental FSO-526A of 260 h.p. The FAA certificate permits operation in weather minima "equivalent to those of single-engined fixed-wing aircraft of similar capacity."

University Space Projects

FINANCIAL grants to British universities for space-research projects totalling £184,540 have been made on the recommendation of the Royal Society's National Committee on Space Research, with the approval of the Government's Steering Group for Space Research. Financial responsibility for this work lies with the Department of Scientific and Industrial Research. The individual items are:

University College of Wales, Aberystwyth (Prof W. J. G. Beynon, £16,530): measurement of electron density/height profile with rockets using Doppler and pulse techniques.

Queen's University, Belfast (Prof D. R. Bates, £15,005): upper-atmosphere rocket research including artificial airglow, altitudes of nightglow layers and study of micrometeorites.

Birmingham University (Prof J. Sayers, £26,000): electron and ion population studies in the upper atmosphere and interplanetary space.

Cambridge University (Dr K. G. Budden, Cavendish Laboratory, £1,694): theory of propagation of radiations from artificial satellites.

Cambridge University (Prof M. Ryle, Cavendish Laboratory, £2,678): recording and interpretation of Doppler and Faraday effects in the radiations from artificial satellites.

Cambridge University (Dr F. G. Smith, £11,230): measurement of cosmic radio noise by receivers mounted on rockets and satellites.

Leicester University (Prof E. A. Stewardson, £13,006): investigation of solar and stellar soft X-ray emissions.

Imperial College, London (Dr H. E. Elliot): (1) £7,275 for satellite measurements of the primary cosmic-ray energy spectrum; (2) £1,500 for investigation into cosmic-ray intensity variations at rocket altitudes.

Imperial College, London (Dr S. H. Hall, £7,935): geomagnetic field measurements in the Earth's upper atmosphere.

University College, London (Dr R. L. F. Boyd): (1) £8,880 for development and use of photo-electric satellite-tracking equipment; (2) £35,450 for rocket research in the upper atmosphere—atmospheric temperature, density and winds; ionospheric temperature, density and composition; short-wavelength solar radiation; and stellar ultra-violet light.

Manchester University (Dr R. C. Jennison): (1) £15,277 for micro-meteorite investigations from an Earth satellite; (2) £15,020 for low-frequency radio astronomy from an Earth satellite.

Manchester University (Prof A. C. B. Lovell, £2,500): tracking of satellites and space probes.

Oxford University (Dr J. T. Houghton, Clarendon Laboratory, £4,560): development of photo-conductive material for satellite measurements of infra-red radiation.

On Public Money

FOR the price of 2s a copy of the Second Report can be obtained from the Committee of Public Accounts, published by HMSO on July 12. It reports on searching investigations into numerous outlets for public money, including the MoA rocket-engine test establishment at Spadeadam (estimated cost in August 1957, £10.9m; estimated cost in July 1959, £20.4, with the likelihood of total cost reaching £25m), three guided weapons (obviously Sea-slug, Thunderbird and Firestreak) and the Dectra navigation aid.

IN BRIEF

It was announced in Washington on July 28 that in future the British Government will be notified of all flights by US aircraft from British bases on missions which will take them near the Soviet frontiers.

Mr Hayne Constant, CB, CBE, MA, MIMechE, FRS, FRAeS, at present director of the NGTE, is to be Scientific Adviser to the Air Ministry from September 1.

The Minister of Defence, Mr H. Watkinson, has appointed a British guided-weapon specialist—from his Ministry, it is understood—to act as a liaison officer with the US Government, the US Air Force, Douglas Aircraft and other organizations on the GAM-87A Sky Bolt.

Joseph Gilbert has been appointed secretary and general manager of the Society of Automotive Engineers, the American organization concerned with the engineering of self-propelled ground, air and space vehicles. He has been assistant general manager since 1957.

Microcell Group announce three appointments in their Electronics Division: Mr L. J. Kennard, AMIEE, to be in charge of the data-handling and process-control section; Mr E. W. Morris, AMIMechE, in charge of automatic weighing system developments; and Mr R. E. Knight in charge of technical sales.

Camloc Fastener Corporation has established a European subsidiary —Camloc Fastener GmbH, Frankfurterstrasse 36, Kelkheim/Taunus, Germany, for the manufacture of its products. New British aircraft in which these fasteners will be used, state the company, include the Bristol 188, Short Britannic and Vickers VC10.

A new twin-engined, four-seat light aircraft is being built by Cessna Aircraft Co. First flight is expected nearly next year, with a production version on the market in 1962. A company spokesman has said that the new machine would represent "a basic new approach to twin-engine aircraft philosophy" and would have a performance superior to any other aircraft in its class.

Mr S. R. Tyler, chief project engineer of Dowty Fuel Systems, has returned from Moscow after presenting a paper on gas-turbine governors at the First International Congress for Automatic Control, attended by 800 delegates from 26 countries. He was accompanied by Mr D. B. Welbourn of Cambridge University (consultant engineer to DFS) who, with Mr R. Ruggles and members of the company, had shared in the preparation of the paper.

General view of Napier's heater-mat balancing rigs. The large rig on the left is for spanwise and balancing; the other is used for balancing in the chordwise plane

Rotor Blade De-icing

SPRAYMAT TRIALS ON WESSEX

THE Napier Spraymat de-icing system has been extended for application to helicopter rotor blades, and three prototype sets of heating mats are now being manufactured, on a production basis, for trials in Canada next winter. The system will be tested on the Westland Wessex, Spraymat de-icing being incorporated in an all-weather version of this anti-submarine helicopter entering production next year.

Unlike the majority of Spraymat de-icers produced for fixed-wing applications, the helicopter heating mats are prefabricated, for bonding to the components by the aircraft manufacturers. This will avoid the transport of vulnerable rotor blades from the makers to Napier's Spraymat shops at Luton and back again.

Actual Wessex rotor spars are being used for the moulds on which the 24ft-long prototype mats are being made. These follow standard Spraymat practice in containing Kumanal heat-sprayed copper-manganese heating elements between two glasscloth laminates. Six such elements, with electrical power supplied at the root, run spanwise, and are connected by a copper contact at the tip. The circuit is completed by a low-resistance pure copper foil bus-bar running spanwise along the upper surface of the heating mat.

The whole laminate is symmetrically disposed around the leading edge, extending on both surfaces to 30 per cent chord, but the heating elements are asymmetrically disposed, their coverage extending to eight per cent chord on the top surface and 27 per cent on the lower surface, where the ice catchment area is greater, due to positive angles of incidence in flight. The heating mats for the tail-rotor blades are essentially similar, but each comprises only one element along the extreme leading edge.

Preparing the connections to the ends of the supply bus-bars of a rotor-blade heater mat

Heating is required to a greater degree over the inboard sections of the blade than toward the tip, where both centrifugal force and kinetic heating aid ice-shedding. This is achieved by lowering the specific resistance of the heating elements in four stages, from 30W/sq in at the root to 20W/sq in at the tip, simply by increasing the thickness of the sprayed element. To speed ice-shedding—and so reduce the possibility of asymmetrical shedding, which leads to rotor imbalance—very high power-loadings are applied. For speed of surface heating the insulation gaps between elements have been reduced to only 0.030in.

The heating mats, and blades, are protected from hail and rain erosion, and from stone damage, by bonding over the outboard 10ft of the leading edge a 2in electriform micrograin nickel sheath. Inboard, where blade flexure is greater, and the erosion problem less critical, the mat is protected by the application of Napier Stoneguard, a synthetic resin heavily loaded with stainless-steel particles, and further coated with Erocoat anti-erosion paint. The nickel sheath is used along the whole length of the tail rotor blades.

Napier work to very close weight and balance tolerances, so that any blade assembly will be interchangeable with all others of its type. Two complex balance-rigs have been built for chordwise and spanwise balance, and heating mats are at present tested for balance at all stages in their manufacture. If the balance is out it can usually be made good in subsequent stages. The primary method of correction is to spray metallic "false elements" in that part of the top surface laminate behind the heating elements.

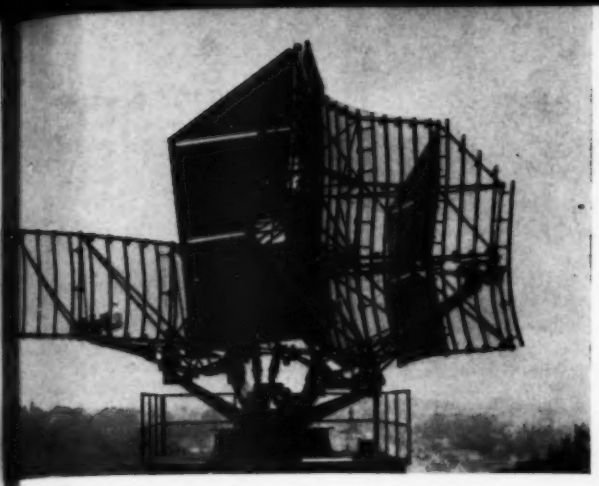
Applying Stoneguard anti-damage coating. The blade is being longitudinally vibrated and gently warmed by an air blower

When in full production, Napier expect that three weight-and-balance checks during manufacture will suffice. Present tolerances on main rotor blades allow ±2oz in the 140oz weight of a main blade mat, ±0.5in in spanwise movement of the c.g. and ±0.05in in the chordwise position. Tail-rotor mats weigh 9oz and ±½oz is allowed in the weight and ±¼in in spanwise c.g. position.

To avoid asymmetrical ice-shedding, matching heating elements on opposite blades are cycled together, so there are twelve cyclic areas for the four main-rotor blades. Two phases of a three-phase Rotax alternator, driven from the main gearbox, provide the power for main-rotor heating, while the third phase supplies the power for the tail rotor mats. An 8lb "cyclic interrupter," developed for Napier by Austinlite Ltd and housed within the fuselage, switches the current, which passes through an 11lb cyclic distributor mounted on the rotor head. The distributor contains a rotary solenoid which is activated when current is passing to one pair of elements and winds a spring device which moves the contacts to connect the subsequent pair. The total power requirement for the system is about 18kVA.

The tail rotor is cycled four times for every full cycle of the main rotor, for, although the aerodynamic effects of ice on the tail blades are negligible, asymmetrical self-shedding leads to very pronounced vibrations. Cycling and cycle timings have not been finalized but will be determined during the winter tests in Canada.

Napier claim that the Spraymat de-icing system can be adapted to any type of helicopter, and one projected application is on the Rotodyne, where the 250°C gases ducted through the rotor blades in the helicopter regime will introduce new problems.



The back-to-back aerials of the Decca DASR.1 10cm surveillance radar which has now been evaluated operationally by the Royal Swedish Telecommunications Authority at Arlanda. A Saab J-29 fighter with an equivalent radar reflecting area of 2.5 sq m was used. Calculations show that with a standard ICAO 10 sq m target, gap-free coverage would be obtained out to about 120 miles at 40,000ft with 80 per cent probability of paint. Visible in the photograph are the special point-source feeds used to achieve true circular polarization by which rain and snow returns are effectively suppressed

FLIGHT SYSTEM SURVEY

Bendix in Germany

A NEW company called Teldix has been jointly formed in Heidelberg by Bendix and Telefunken for research, development, manufacture, service and sale of aircraft systems and equipment. Managing directors are to be James B. Tracy, formerly manager of the B-58 systems project with Eclipse Pioneer, and Fritz Krumling of Telefunken.

Among the new company's projects will be the manufacture and servicing of airborne systems and navigational units for the F-104G and G 91. These two aircraft will have the PHI navigation computer produced by Bendix in the US and the G 91 will have Bendix Doppler.

Compagnie Européenne d'Automatisme Electronique

Two French companies, CSF and Intertechnique, have signed an agreement with Hhompson Ramo Wooldridge for the formation of a new company under the above name. With a head office at 8 Rue Lavoisier, Paris, it will produce and sell digital computers for automatic control of industrial installations within the common market, and will benefit from technical assistance from the American company.

International Aeradio at Cairo

THE United Arab Republic has placed a contract under which International Aeradio will install and operate certain of the airfield services at the new Cairo international airport. Four consoles are to be provided respectively for HF radio, approach control, telecommunications control and ground services control, including telephone and teleprinter service using specially designed control units. The four positions will link up with numerous other standard communication systems purchased separately.

This operation is typical of IAL's work in coordinating the use of a wide variety of equipment at common operating positions. The consoles themselves will be based on the standard IAL unit.

Bristol Electronics

BASED on many years experience in the design of specialized electronic instrumentation, the Electronics Department of Bristol Aircraft Ltd is now offering to industry specialized consultative, design and engineering service in the field of automatic data processing equipment, analogue/digital converters, multi-channel digital recorders, galvanometer amplifiers, resonance test equipment, radome test equipment and automatic heating and loading equipment. The Bristol Electronics Department will design and build equipment to meet the requirements of a particular project or will undertake vibration and resonance testing, strain gauge analysis and acoustics test work; it will also, if required, act in a consultative capacity. Some of the equipment is listed here.

The multi-channel digital recorder is based on the earlier Mk III modules but has certain refinements. It is designed to read both strain gauge and thermocouple inputs from up to 72 channels, a proportion of which may be selected for automatic and repetitive reading. A single channel may also be manually selected when required. Reading speed is 90 channels per minute and read-out may be in tape punch, typewritten record or in-line printer. The tape-punch code may be easily changed and manual operation can be provided.

The automatic heating and loading equipment employs tapes on which heat and load programmes are punched and passed to the control units. Alternate lines of holes give destination and signals which are fed to binary coded attenuators and appropriate controls.

The galvanometer amplifier employs six plug-in channel amplifiers which, in conjunction with a 12-channel Mingograph galvanometer jet recorder, will produce an immediate record of low-level transducer signals in the frequency range of 0-2,000c/s.

The automatic data processing equipment accepts FM information on standard magnetic tape and produces analogue graphs on paper film or Hollerith cards suitable for further analysis or computation in a computer such as Deuce. Automatic drift compensation and non-linearity correction, a galvanometer trace recorder, absolute time reference and self-checking facilities are included.

The X-Y resolver and phase amplitude display is a self-contained resonance test equipment developed for ground resonance tests, models and wind-tunnel work and flight flutter investigations. The frequency sampling coder is a telemetry set feeder which will make high-grade data from a transducer compatible with the lower grade input normal in the telemetry modulator. It time-multiplexes electronically over ten transducers so that one high-accuracy reading and two samples of up to 16 lower accuracy ones can be made with a 24-way switch for each pair of cycles of time-multiplexing.

The analogue/digital converter is of a new and possibly unique type and provides a binary digital output linearly related to the value of the parameter to be measured, with automatic correction for overall system gain and level variations. The output used consists of a voltage analogue of the required parameter, a number of voltage standards and a train of "read" pulses.

The radome test equipment includes a transmitter giving a plane-polarized uniform field of appropriate radius, a movable mount and receiver for the radome and a rack of data plotters, receiver components and controls. Transmitter power is varied by a servo-controlled attenuator which provides a measure of absorption losses for plotting on a chart recorder.

FAA Extends Microwave Links

A CONTRACT worth $5,168,533 has been awarded by the Federal Aviation Agency to Collins Radio Co for the manufacture and installation of 20 additional microwave link systems to carry radar information from remote aerial sites into air route traffic control centres. Four of the links will be for joint use between FAA and the US Navy and USAF and the first is to be delivered in March next year. The exact sites in the US and Alaska have not yet been determined.

Reporting the new contract, FAA states that radars with a range of 200 miles are essential in the control of traffic on airways and that the links will have a range of up to 30 miles and in some cases as much as 250 miles. A number of microwave links are already in use.

Elliott 503 with High-Speed Switching

THE new Elliott Automation 503 digital computer incorporates the ultra-high-speed switching techniques recently announced by the company. The switching time of five milli-micro seconds makes the 503 one of the fastest computers available anywhere and gives it a capacity much higher than that of conventional machines. The 503 retains the simple, easily understood instructions of earlier Elliott machines; and the complete system being evolved round it will incorporate unlimited extension of storage facilities by the use of new high-speed magnetic tape units, a wide range of input and output equipment and special keyboards for the running of parallel programmes. The increased capacity will also greatly reduce the unit cost of work.

IBM Navigation Computer

PRIMARILY for space travel, International Business Machines Corp have developed equipment which will project an accurate map of an area 400 miles in diameter on to a small screen in front of the pilot of an aircraft. An airborne computer which forms part of the system carries out all the calculations necessary to adjust the map on the screen, as the aircraft moves, so that the pilot is shown his location throughout the flight. For space travel a stellar map would be projected and a telescope view from the space vehicle superimposed on it. The computer would then automatically calculate the position of the vehicle in space.

Straight and Level

LADY BOOST rang me last Friday morning. I asked her how she was keeping.

"I'm quite well, thank you, but Boostie is dreadfully upset. He's just been reading his morning paper and I think you may be the only person who can soothe him . . ."

". . . THAT YOU, BACON?" interrupted the familiar voice of Plummet Air Lines' chairman, champion of British supremacy in the air. "I must talk to you at once. I tell you, old boy, it's a matter of life or . . ." His voice trailed off into the most dreadful choking noises.

Naturally most concerned, I went round to his town house in Belgravia straight away. Still wearing the space suit in which he had attended the previous night's Air Power Club fancy dress ball, he bellowed at me hoarsely: "This fellow d'Erlanger of BOAC says that supersonic airliners will be 15 to 50 per cent more expensive to operate than present jets. Raspberrries, raspberries, raspberries, I say to that, and you can quote me in your lousy column. Have a drink."

* * *

"All right, Boostie, but what *are* supersonic airliners going to cost?"

With a coy twinkle in his eye, Sir Charles folded down from the wall the biggest brochure I had ever seen. Bound in hand-tooled molybdenum steel, and fitted with a hydraulic page-turning system, it was entitled *Analysis of the Cost of Operation of the Scruggs SA.461 Supersonic Transport—Plummet Management Information Office, Report No. 400135, August 1960.*

"According to our estimates, old boy, the supersonic airliner—just let me get you the exact figure—yes, here we are, the supersonic airliner will be 46.3 per cent cheaper to operate than the VC10, which might just as well be thrown away. This is what my chaps estimate, and I pay them well. Of course, Scruggs say that the SA.461 will be 62.6 per cent cheaper, but we never believe manufacturers' figures." At this point Sir Charles crumpled up with mirth.

"What first cost are these estimates based on?" I asked. "Scruggs must know pretty precisely, it seems."

"First cost?" Again Sir Charles almost choked with laughter. "You tell me, old boy. But I tell you that whether it's £5m or £50m the supersonic airliner will be 46.3 per cent cheaper to operate—maybe only 46.2 per cent. Anyway, you can see that d'Erlanger is talking through his hat. Have another drink."

● Probably the briefest letter ever to appear in the correspondence columns of *The Times* was published on July 26. A contribution to the argument about cross-Channel transport, under the heading "Tunnel or Bridge?" it was signed by Eoin C. Mekie, chairman of Silver City. It read:—

"Sir—why either?

Yours faithfully."

● I have often wondered at the Russians' apparent lack of enthusiasm for genuine all-freight transport aircraft. There is a military counterpart of the An-10, generally similar to the passenger-carrying aeroplane but with rear loading. But they have no range of transports with the classic all-freight character of the C-118, C-130 or C-133. If they had, would not such aircraft have been used for the United Nations Congo airlift, instead of Il-18s?

● We are always saying in this country that our labour costs are much lower than those of the Americans, though I must say that our civil aircraft prices never seem to be very much below theirs. Perhaps we make more profit. I don't know. But I have some real evidence that we *can* produce the same things very much more cheaply.

The other day I read that General Precision Inc are offering a sort of utility flight simulator called the Simulette. It will cost about £80,000 which, says the American firm, is about a fifth of the price of a full-scale 707 or DC-8 simulator.

Thus an American-built full-scale 707 simulator costs about £400,000. May I recommend that, before parting with this sum, airlines have a word first with the British firm Air Trainers Link—a GP company—which produces excellent big-jet simulators at £100,000-£130,000 a time?

● Is our V bomber deterrent effective on slushy February days? Or do we lose the 15min warning period in sweeping the runways?

The accident at Munich, and sundry other incidents, have focussed attention on this problem. Has anyone tested the performance of the V-bombers under these conditions?

● The cost to date of efforts to salvage the Victor that mysteriously crashed over the sea off Pembrokeshire 11 months ago, so the Admiralty tells us, is about £1½m.

For not much more than that amount of money every Victor in the RAF, probably every Vulcan too, and perhaps every one of the new types of civil and military aircraft now in service, could have been fitted with flight recorders.

In America the installation of flight recorders is to be mandatory in all new civil transports. These devices don't prevent accidents, but at least they may help to establish the cause quickly. The cost is not light. But neither is the cost in lives of the second accident that crash recorder evidence might prevent.

● I draw attention to the fact that the world's airlines did not, as everyone has assumed, make a loss in 1958 of £61m. The annual ICAO report for 1959 says that the "preliminary estimates given in last year's report had to be modified rather more than usual owing to errors in the early statistical reports received from several governments. The correct figures for 1958 indicate a small net operating profit for the scheduled airlines of the world of $15m (£5.35m)."

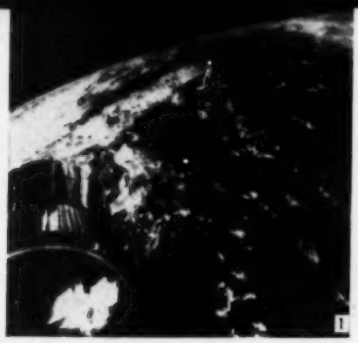
It is nice to think that even a body as authoritative and apparently infallible as ICAO is capable of dropping such £66m statistical clangers.

Vital Clue

● "It seems possible that the scattered fragments fell from a height, suggesting some kind of explosion or sudden disintegration in the air. This may have been in the engines or in the aeroplane."
—*Newspaper report.*

ROGER BACON

How much easier life would be if big jets grew like lettuces. Though this bed would need a bit of thinning out, because each of these TWA Boeing 707s measures one foot in span. They have another distinction in being made in Britain—the airline wanted "first-class workmanship." This consignment of a hundred is to be shipped aboard a full-scale specimen and is only the first. Her name, by the way, is Chris Hubert



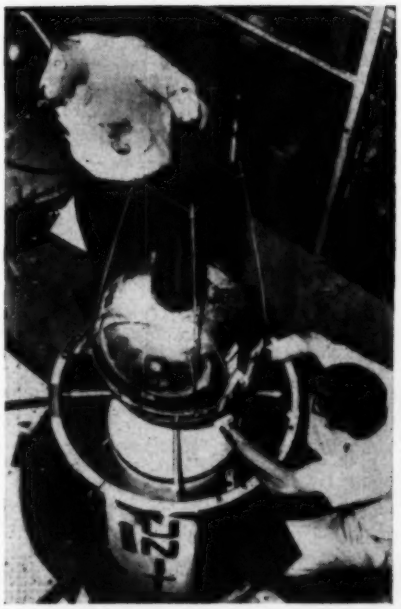
SPACE SPECIAL

★ A "Flight" review of various major aspects of spaceflight at the present time, with particular reference to the American scene and the respective achievements of US and Soviet spacecraft.

★ On the British scene, also described, the prospect remains one of uncertainty, with the decision concerning possible space boosters once more postponed pending discussions with the Australian Government.

★ Internationally, some 600 space scientists, technologists and allied specialists are meeting this month in Stockholm, where the International Astronautical Federation is holding its eleventh Congress. As well as some 65 main-session papers, four specialized meetings will be held, devoted to space law, astrodynamics, space medicine and sounding rockets. The Congress will be fully reported in future issues of "Flight".

★ Typical of current spaceflight activity are the photographs on this page. Top group, Thor-Able 3; the Earth from an Atlas; Jodrell Bank radio telescope; rhesus monkey Sam after Mercury capsule flight; Cape Canaveral blockhouse. Left, Soviet astronaut in pressure chamber; US astronaut leaves capsule. Bottom row, Moon photograph by Lunik 3; US astronauts weightless in Convair; model of Sputnik 3. Right, Vanguard 3 is prepared for launch.



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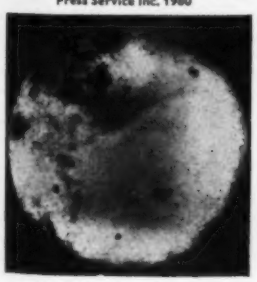
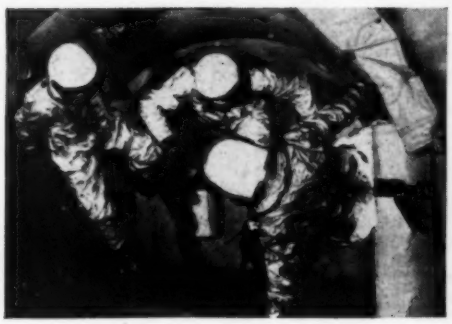




Launch of Atlas-Agena carrying Midas 2 satellite on May 24

AMERICA'S SPACE PROGRAMME

By a Special Correspondent

SPACE is a political issue in the United States this year. What the Russians had not done to make it so, American politicians have done—or will do between now and November, when the national elections are held. America's second place in space, tacitly admitted by Dr T. Keith Glennan, Administrator of the National Aeronautics and Space Administration, has long produced an uneasy feeling in the minds of many Americans. Public-opinion polls, usually insensitive to more than likes and dislikes for individual candidates, have picked up the general public's feeling of shame, surprise, embarrassment and more than a little fear that "we're behind in space."

This feeling was evidenced even last year on many a residential street in the US, when a surprising number of people could be found standing in the middle of the street at dusk better to observe the reflected light from the fast-moving Sputnik 3 as it passed overhead. It was further shown when Congress quickly passed a record $915-million budget for NASA for the year that began July 1, 1960, and opined that supplemental appropriations would be available later on if NASA saw the need. The Space Committee of the House of Representatives went further, and spanked NASA for not moving ahead at a faster pace, for a "lack of urgency," and for not having a programme ambitious enough for the needs of the next decade.

NASA's problems have been many and varied from the start. Originally, it was presented to the public as a sort of emerging butterfly of space from the chrysalid of the old aviation-oriented NACA. A stroke of the presidential pen ejected an entire civil service organization from the safety of the atmosphere to the uncertainty of space. That there was floundering is not surprising.

The Administration also took over established space facilities and personnel from the Navy, Army and Air Force—which meant that a lot of roots were torn up from Service soil and replanted in old NACA soil, with the inevitable shifting around and soul-searching among the people concerned in the various units.

When it was created on October 1, 1958, NASA had a staff of 8,040 people who came from NACA. These were located for the most part at the Langley Research Center in Virginia, the Ames Research Center in California and the Lewis Research Center near Cleveland, Ohio, in addition to headquarters personnel in Washington and a small group of flight test specialists at Wallops Island, Virginia.

By June 30, 1961, NASA expects to have a total of more than 16,000 employees and will pay them salaries adding up to $171 million per year. Some 2,000 of them will be at the new Goddard Space Flight Center near Beltsville, Maryland, now under construction as the future headquarters of all NASA spaceflight activities.

In addition, NASA acquired some 400 people about 18 months ago from the US Navy's Naval Research Laboratory. These were Vanguard specialists who were transferred to the space agency. Then, last year, NASA took over contract operation of the Jet Propulsion Laboratory at Pasadena, California, from the US Air Force, and this brought 2,700 contract employees under NASA direction. Only a few weeks ago NASA took over the Marshall Center at Huntsville, Alabama, from the US Army. In the process it got Dr Wernher von Braun and his tightly knit, able and publicly recognized crew who developed the Jupiter and Redstone rockets, and who launched the first successful US satellite. Some 5,500 people are involved in the latter transfer, the largest single body of personnel NASA has absorbed. As a result of these shifts, NASA has had to spend much time so far just working out the problems of its own management.

NASA plans for this decade call for some 250 major launchings of space vehicles, including flights to circumnavigate Mars and Venus. There are to be unmanned landings on the Moon, and perhaps even return flights, but no man is to be put on the Moon until the 1970s, according to present schedules. This is one thing for which NASA is criticized in Congress for "lack of a sense of urgency," inasmuch as a number of US scientists have suggested that a manned lunar landing could be made as early as 1968.

Undoubtedly the Space Administration's spending will increase. Dr Glennan has estimated that it might reach two or three billion dollars a year during the next decade, and perhaps even more. Predictions here are at best only estimates, and rather wild ones at that in view of the diversity of programmes under way and the inter-related way they will affect one another in the years ahead.

Since it came into existence, NASA has had to rely upon military equipment to conduct most of its space research, but it always realized that it would have to go far beyond the boosters and other equipment available from the Air Force, Army and Navy if it were to accomplish its basic mission.

The space agency has been faced with the need to bring the USA abreast of the Soviet Union in space, to develop and prove new instruments to conduct investigations of space, to demonstrate communications and meteorological satellites, to develop new and very much larger boosters for deep space research, and to develop propulsion techniques for use in outer space. At the same time it had to carry on its regular quota of aeronautical research, including the X-15 programme.

To date NASA results are at best spotty, with two happy events as prime examples of its best effort. They are the Tiros I weather satellite, which transmitted 22,952 cloud-cover photographs in the 89 days its instruments functioned, and the successful Pioneer 5 paddlewheel probe that has transmitted space-environment data from more than 20 million miles out.

NASA is now entering a new period in which it is more master of its own house, and the rate of progress will be much faster. Even so, this progress must come in orderly, logical steps of progression. Instruments must be designed, built and space-tested before they can be utilized in space vehicles. The space environment must be investigated and better understood before manned flights deep into space, or even as far as the Moon, can be attempted. To accomplish these things, NASA has undertaken a vast programme of scientific research. Larger space probes able to penetrate either deeper into space or to carry more and heavier equipment are needed now, but this programme is frustrated by the lack of large-scale boosters and must await the development of Centaur, Saturn and Nova.

Meanwhile, Project Mercury, to put a man into a low orbit around the Earth, is going on as a more or less special project, somewhat peculiar unto itself. Like it or not, the US, in announcing Mercury, got itself into a tough race with the USSR. The unmanned capsule the Russians put into orbit at the time of the

summit meeting in Paris earlier this year confirmed NASA's worst fears. Until then the Russians had coyly refused to talk about their man-in-space programme and even had displayed a lack of interest in such a project. Many in the US associated with space research believe the Russians will try to put a man into orbit around the Earth before the American elections take place in November.

NASA was but four days old when it undertook Project Mercury in 1958. Soon it had put out requests for quotation to industry to come forth with ideas for a suitable space capsule, and McDonnell Aircraft Corporation in St Louis won the award. Farsightedly, McDonnell Aircraft had seen the need for such a capsule much earlier and had completed extensive study and design work in advance.

The capsule for Project Mercury is shaped something like a huge television tube, with a large, blunt end that must take the heat that develops during the re-entry phase of the mission. This blunt nose is covered with a resinous material embedded in glass-fibre. During re-entry it will encounter temperatures as high as 2,600° F, and under this hot blast the material will slowly vaporize.

One shot of the Mercury capsule with an astronaut aboard will be made later this year. It will be only a ballistic trajectory shot, however, and the astronaut should be recovered 200 miles down the Atlantic Missile Range. Several test shots have been made, including one very successful shot of a complete capsule with a monkey as its occupant. This was carried out at NASA's Wallops Island facility, and the capsule was carried aloft by a Little Joe solid-propellant booster. The shot went off well and the monkey was recovered hale and hearty.

A second similar shot is to be made in the fourth quarter of this year, and then, finally, a manned ballistic trajectory shot. The actual firing of the latter will take place at Cape Canaveral and a Redstone booster will be used.

Additional sub-orbital shots are scheduled in 1961 using Redstones. Two are lined up for the first quarter of next year, three for the second quarter, two in the third and, finally, one in the fourth quarter. Two sub-orbital Atlas-boosted firings of Mercury capsules also are scheduled for the first quarter of 1961. Some of the sub-orbital shots will be used to give all seven of the Mercury astronauts an opportunity to be checked out in a space capsule.

NASA is trying to make certain that the Mercury flights will be no more dangerous to the astronauts than if they were testing experimental aircraft. Each man is a qualified military test pilot with jet credentials and 1,500 hours or more of flight time. Each is an engineer, less than 40 years of age, and none is taller than 5ft 7in.

When NASA issued its call for potential astronauts, more than 100 young men responded. Of these, 69 were interviewed, and 32 were chosen for a series of tests involving both physical and mental capabilities. Seven were selected, and the judges displayed their keen appreciation of inter-Service rivalry in the US by selecting three from the Air Force and the same number from the Navy. The seventh is a Marine. The Army is not represented, presumably because it is restricted with respect to aviation and does not have pilots who could meet all the qualifications—especially the jet-pilot requirement.

The youngest astronaut is 33, the oldest 39, and all are married and fathers of at least one child. Training is rigorous at the Langley Research Center near Hampton, Virginia. The seven men must learn what to expect in space both in theory and practice—or as much of the latter as can be duplicated. As a result, they have been strapped into centrifuges to reproduce the g forces they will encounter during launching and from deceleration (up to 11 times body weight) during re-entry. They experience weightlessness by riding jet aircraft put through an over-the-top arc, and they gain the experience of tumbling in space by riding a Multiple Axis Space Test Inertia Facility (MASTIF) installed at the Lewis Research Center, Cleveland, Ohio. This bizarre device simulates a three-dimensional whirligig to reproduce Mercury control problems. An astronaut learns to control the action of the MASTIF chair by adjusting the small levers of the side-arm controller at his fingertips. Similar controls will be used aboard the Mercury capsule.

The Redstone booster that will put an astronaut into a ballistic flight from Cape Canaveral later this year will carry him to an altitude of 125 miles. He will achieve a speed of 1,600 miles per hour in the first five minutes, and will be let down 16.5min later in the ocean about 200 miles downrange.

For safety during launching, Mercury has a specially designed escape device attached to the small end of the capsule. Its basic feature is a rocket that can be ignited to lift the capsule free of the booster and let it down by parachute in the event of the booster failing during launch. This escape procedure has been tested many times, once with a specially trained monkey, and has worked well.

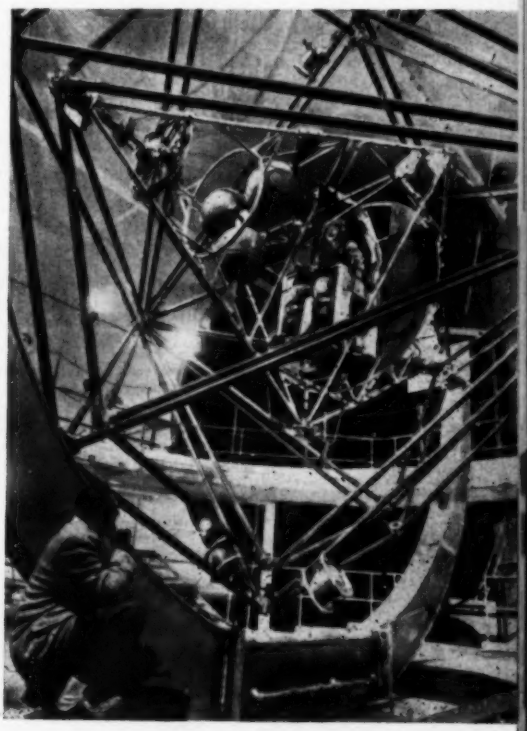
Inside the capsule, the astronaut is shielded from heat, cold and noise by a double wall. The outer shell consists of heat-resistant cobalt steel, the inner shell is titanium, and there is heavy insulation between.

Redstone will achieve burnout in two minutes and, at an altitude of 45 miles five seconds later, Mercury will separate from its booster. First, the escape device on the front of the capsule will be fired free. Then separation rockets mounted to the blunt or seat end of Mercury will be fired to effect separation between the capsule and booster. The arrangement is such that the capsule is shot slightly to one side as well as forward of the path of the booster lumbering along behind.

Small jets then take over automatically to turn the capsule so that the blunt end is forward and ready to absorb the heat of re-entry. These same jets, working automatically and employing hydrogen peroxide as propellant, are used to control roll, pitch and yaw. The astronaut can override the automatic controls, however, by taking over manually during the descent if he needs to do so.

The separation rockets will become retro-rockets when the blunt end of Mercury has been turned forward, and they will be fired to slow down the capsule and cause it to re-enter the

Right, disorientation tests in the Multiple Axis Space Test Inertia Facility at Lewis Research Center form part of the Project Mercury man - in - space programme. Below, one of the Mercury astronauts familiarizes himself with capsule and "cockpit"



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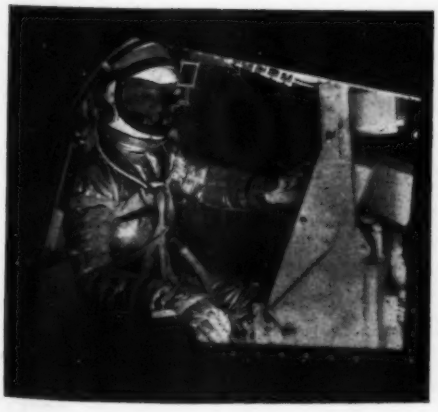
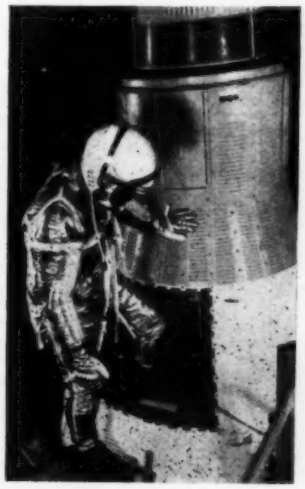
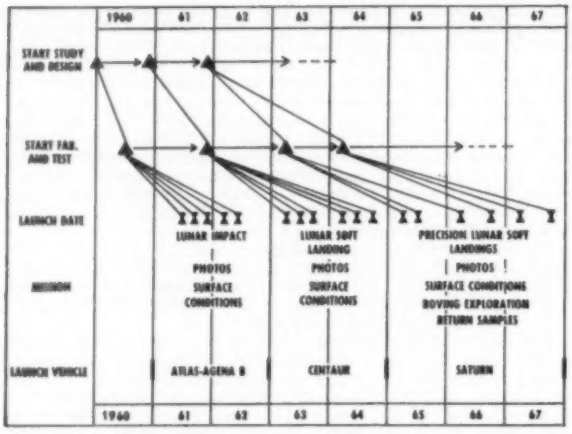
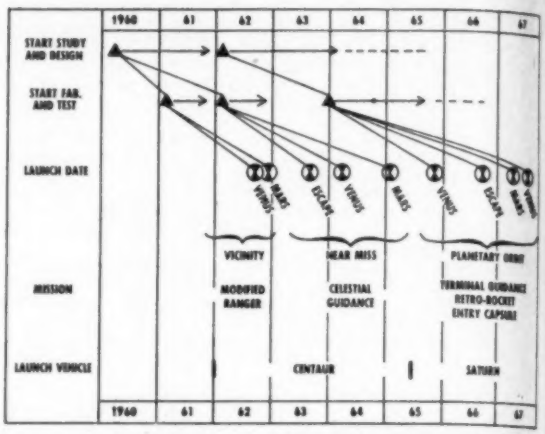








These charts show NASA estimates of the necessary lead times before it can carry on unmanned exploration of the Moon (left) and the planets Venus and Mars. The space agency has been criticized by Congress for not having a sense of urgency about its space programme and was urged to speed development of equipment for manned flights into space

SPACE SPECIAL

AMERICA'S SPACE PROGRAMME . . .

atmosphere. Once this is accomplished, the retro-rockets will be jettisoned.

Should the yaw jets fail completely, there is a mechanical spoiler on the small end of Mercury that can be used to flip the capsule into a large-end-forward position. When Mercury hits the atmosphere, the spoiler will also serve to hold the capsule more or less blunt-nose forward during re-entry.

Inside his cabin, the astronaut will be in a complete air-conditioned pressure suit. He has a periscope that can be kept pointed toward Earth by adjusting the roll-control jets. Infra-red cells installed in the small end of Mercury will scan the horizon and will control the equilibrium of the vehicle.

The astronaut rides on his back during launch, and he rides backwards also during re-entry. His controls will be in the arm-rests of his seat and he will manœuvre them, as necessary, with his fingers. He will have radio communication with the ground, and his physical-psychological reactions will be telemetered to ground receiving stations. Film packs alongside will show, when recovered, the penetration of cosmic rays. A movie camera overhead and to one side will constantly photograph the small instrument panel showing altitude, position, equilibrium, etc.

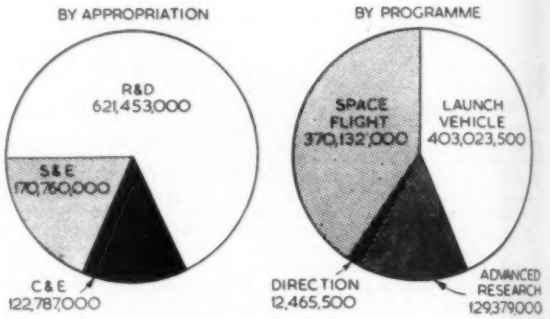
At altitudes between 80 and 40 miles above the surface of the Earth the astronaut will feel his condition change from weightlessness to about 11 times his normal weight. This complete change, due to the deceleration imparted by the ever-denser layers of the atmosphere, will occur in about sixty seconds.

During re-entry, the capsule's speed will be reduced from about 4,000 m.p.h. to a few hundred and then, at about 12 miles above the Earth, a small braking parachute will be released from the small end of the capsule to slow the descent even more. Finally, at about 10,000ft, a 63ft parachute will break out to slow the speed of descent from about 300 m.p.h. down to 25 m.p.h. The larger parachute will carry the capsule down to the water.

When the main parachute opens, a perforated skirt of flexible glass-fibre, four feet long, pops out of the blunt nose of the capsule. This skirt not only will cushion Mercury's fall into the Atlantic, but will give it a stabilizing keel.

A radio rescue beacon is installed in the small end of Mercury. The beacon automatically inflates a small balloon with helium after the capsule hits the water and plays out an antenna that is supported by the balloon. The radio beacon automatically broadcasts a code to guide rescuers to the scene. In addition, a dye marker is spread upon the surface of the ocean to assist in finding the capsule and the astronaut, who works his way out of the vehicle through a port in the side.

A series of Atlas-launched unmanned Mercury shots have been scheduled for late this year and next. Most landings will be made 4,000 miles down range. On one of these shots, the Mercury capsule will carry an artificial crewman—a device that



NASA's $915-million budget for the 1961 fiscal year (compared with $523,575,000 for fiscal 1960) will be spent in this manner. The launch-vehicle programme (mostly Saturn) will cost more than $403m, whereas current spaceflight programmes (including the X-15) are covered by the $370m. The advanced research programme of $129m includes the 1.5 million-pound thrust F-1 rocket engine and development of hydrogen engines. The "direction" segment is for liaison work with the Services and certain headquarters activities. The "appropriation" division on the left is for research and development, salaries and expenses, and construction and equipment

DISTRIBUTION OF NASA RESEARCH-CENTRE EFFORT (DECEMBER 1959)

Research Application	Percentage of Effort
Manned spaceflight	26.3
Lunar and interplanetary vehicles	15.9
Launching vehicles	14.0
Supersonic aircraft	11.4
Unmanned Earth satellites	8.1
Ballistic missiles	7.4
VTOL and other special aircraft	5.4
Hypersonic aircraft	5.0
Manoeuvrable missiles	3.3
Subsonic aircraft	3.2
Total	100.0
Summary	
Space missions	64.3
Manned aircraft	25.0
Missiles	10.7
Total	100.0

NASA SOUNDING-ROCKET PROGRAMME FOR NEXT 18 MONTHS

	FY 1960		FY 1961			
Quarters	3	4	1	2	3	4
Atmosphere	3	4	4	4	3	3
Synoptic atmosphere	2	2	9	9	6	6
Ionosphere	2	2	2	2	2	2
Energetic particles	2	6	2	1	3	2
Magnetic field	–	5	1	–	2	3
Astronomy	6	8	8	8	6	6
Special	10	3	3	1	2	2
Totals	25	30	29	25	24	24

imitates an astronaut's oxygen consumption, carbon dioxide, heat and moisture production (including two artificial urinations).

Another of the Atlas shots will take a chimpanzee on three orbits around the Earth and put him down in the Atlantic north-east of Puerto Rico in an exact run-off of the forthcoming manned orbital flight. Finally it will be the astronaut's turn, probably before next summer, to make the same trip. Two astronauts will in fact be selected, one as primary and the other as an alternative. Launching will take place at night to assure more daylight hours for the search to find him after he lands.

The path selected for the first US manned orbital flight is more or less near the equator so as to keep the capsule over friendly territory. There are to be three orbits around the Earth at 17,500 m.p.h., requiring about 4hr 30min of flight in space. Some 17 tracking stations will be set up and 500 technicians will be following Project Mercury's progress. (The US Government has not yet succeeded in gaining permission to set up two of the 17 stations in Zanzibar and Nigeria.)

There will be other flights with other Mercury capsules at later dates. Just how many it is too early to say, but plans are under way now in NASA to invite bids on a project that will carry three men into orbit and hold them there for several days before recovery is made.

Before manned flights can be made into outer space, to circle the planets and to land on them, NASA must learn much more about the space environment and how to overcome problems encountered there. This is an area that requires intensive research and step-by-step study using unmanned vehicles. NASA takes special pride in the progress it has made to date in learning more about space, and it is confident that the USA is ahead of the USSR in such knowledge (see comparative article on page 187).

The emphasis which NASA places on scientific results can be seen in its short-range plans for no fewer than 55 high-altitude rocket sounding shots in the last half of 1960, and more than 100 in 1961. This extensive programme has been designed with two purposes in mind.

First, it is to provide qualifying tests for instruments that later will be used in space satellites. Second, there is a great need for direct measurement of conditions below the level at which satellites can survive. Sounding rockets will therefore be used to measure a variety of conditions between sea level and 100 miles above the Earth's atmosphere.

Many sounding rockets will be fired from Fort Churchill, Manitoba, with the co-operation of the Canadian Government. Some will be fired from Wallops Island, Virginia, and others at a variety of other locations. The shots will collect data on a vertical slice of space up to 4,000 miles, or one earth radius.

As fast as the new instruments are developed and tested they can be incorporated into more advanced NASA vehicles, such as those being developed for unmanned Earth satellite missions over the next four years. Already some 33 such missions are visualized by NASA through 1963. Essentially they are of three main types:

(1) Meteorological satellites, such as the very successful Tiros launched by a Thor-Able rocket on April 1 of this year. Tiros is equipped with both a narrow-angle and a wide-angle camera and, before it went dead after 89 days of transmission, it sent back to Earth 22,952 pictures of cloud cover. A second Tiros is scheduled to go into orbit during the fourth quarter of this year and a more advanced meteorological satellite, the Nimbus, is being developed for a shot late in 1961.

(2) Scientific satellites, such as the Vanguard, Pioneer and Explorer series, to learn more about space and how it may be used safely and successfully by man. These flights carry instruments to measure radiation, among other things. It was Explorer 1 which discovered the Van Allen radiation belt around the Earth. Magnetic fields in space, the interaction of radiation from outer space upon the magnetic field around the Earth, and subjects of this nature are being studied. The requirements for the radiation shielding necessary for any vehicle in which man might fly to the vicinity of the Moon or to some of the other planets will be carefully examined.

(3) Communications satellites, such as Project Echo, a 100ft aluminium-coated plastic sphere launched to an altitude of 250 miles or higher and at speeds of about 9,000 m.p.h. A passive communications satellite, Echo's sphere reflects radio and radar signals for investigation of forward-scattering techniques useful in communication and propagation. Already Echo has been used successfully for such purposes, and more tests will be made in the future on a more or less unscheduled basis.

Echo may also be employed as a lunar probe. Using existing astronomical equipment, the position of an Echo satellite can be accurately measured throughout a lunar flight, and therefore the location of any instruments carried inside the 100ft sphere would be known at the very instant those instruments were recording lunar measurements and sending them back to Earth.

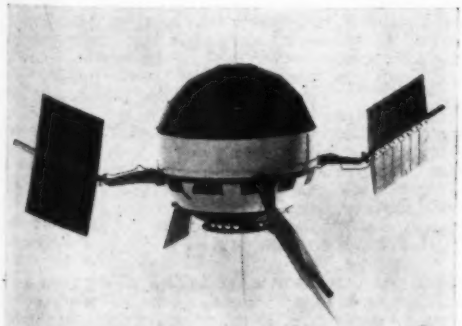
As already noted, the most restrictive element in the American space research effort is the lack of large-size boosters. Very large boosters for deep probes simply will not be available until the latter part of the 1960s, though work on them carries a high priority.

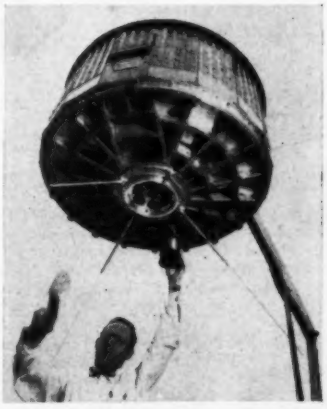
Two launch vehicles which began the US space effort have already been discarded. They are the Jupiter C and the Vanguard IGY satellite vehicle. Due for retirement late this year are Juno 2, based on the Jupiter IRBM, and Thor-Able, a version of the Air Force Thor IRBM.

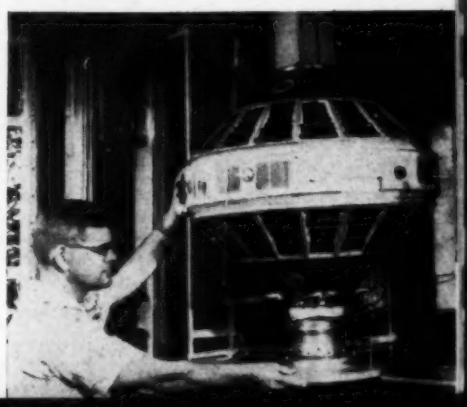
Thor-Delta, an improved Thor-Able with a flexible radio-guidance system, will be used next year in a programme calling for 12 launchings, but after that it probably will be cancelled. The NASA Scout vehicle, a small, low-cost ($750,000 each), four-stage solid-propellant rocket, recently tested with partial success, will replace Thor-Able in many applications. In addition the Thor-Agena-B will come into use next year, as well as the Atlas-Agena-B.

NASA's Centaur is scheduled to be launched next year, the first boster with a high-energy upper stage, using liquid hydrogen and oxygen instead of the more conventional kerosine and oxygen. Saturn, discussed elsewhere in this issue and intended to be ready for space missions by 1965, follows Centaur. And, by 1967, NASA hopes to have Nova ready for use in powering manned missions deep into interplanetary space. At this time, Nova is merely a concept of employing the Rocketdyne F-1 rocket engine developing 1.5 million lb of thrust. The first F-1 will be tested soon at Edwards Air Force Base, California.

NASA is investigating possibilities beyond Nova, too. Along with the Air Force it is looking into nuclear rocket propulsion. And for space propulsion it has let study contracts to two companies to study electrical systems powered by nuclear reactors.







Contrasting US satellite and probe payloads (clockwise from the right): Tiros 1, launched by Thor-Able, relayed almost 23,000 cloud-cover pictures; Explorer 7, launched by Juno 2, carried an ambitious variety of radiation experiments; Transit 2A (lower) and the Naval Research Laboratory satellite were launched together by Thor-Able-Star; Pioneer 5, placed in solar orbit by Thor-Able, communicated with Earth at the record distance of 22.5 million miles

SPACE SPECIAL

AMERICA'S SPACE PROGRAMME . . .

The programme for boosters and payloads is an extensive one. Two radiation-belt studies using Juno 2 are to be made later this year. One other such shot has failed. Juno 2 is capable of placing 100lb into a 300-mile orbit. It consists of one large, liquid-propelled first stage; a second stage made up of a cluster of 11 Sergeants; a third stage of three scaled-down Sergeants; and finally a fourth stage consisting of a single scaled-down Sergeant. With a gross weight of 122,000lb, Juno stands 77ft high (overall) and has a diameter of 8ft 9in. It has launched three Pioneers, including America's first satellite, and an Explorer.

The Juno 2 vehicle was originally scheduled to handle several shots in 1961, but these recently were re-scheduled to Thor-Delta, which is capable of putting 500lb into a 300-mile orbit. Of the 12 Thor-Delta shots planned for 1961, one will measure ionospheric properties, two will measure gamma and cosmic rays, and two more will test out ideas for an ionospheric beacon.

Another use of Thor-Delta will be to launch Echo balloons to very high altitudes. The Delta coasts for as long as 15min before ignition of the guided third stage, which makes possible very accurate placement into orbit.

Scout is a specially designed, low-cost booster. Its four solid-propellant stages make it an all-purpose vehicle particularly useful for NASA's scientific research programme that will receive so much emphasis over the next 18 months. Scout will be used for many of the sounding shots, but it also is adaptive to the requirements for orbiting, and can place 200lb into a 300-mile orbit.

Flight testing of this important vehicle began in July, with only partial success. The fourth stage was not ignited and the vehicle was destroyed because of some erroneous radar information which made it appear that the Scout had gone off course.

The first Scout scientific shot has been scheduled for the fourth quarter of 1960, with four more in 1961 as a minimum, five in 1962 and two in 1963. Two shots to be made in 1962 will be aimed at learning more about the ionosphere over the Poles, and to carry out polar radiation studies. A shot scheduled for 1963 will be concerned with polar atmospheric structure.

Although it has not been definitely announced, the polar shots will quite likely be made from the new Pacific Missile Range near Point Arguello, California, which is ideally suited for polar orbits since the various booster stages can drop harmlessly into the Pacific.

By 1962, Scout will have replaced all of the liquid-propelled vehicles for orbiting small payloads. A big step forward will be made in 1962 and 1963 when the Thor-Agena-B and Atlas-Agena-B series become available. With the Thor-Agena-B it will be possible to put a payload of 1,600lb into a 300-mile orbit, and with the Atlas-Agena-B to put 5,300lb into a similar orbit or, alternatively, to accelerate 800lb to escape velocity. The Agena-B will be quite manœuvrable in space and will have an engine—an advanced Bell Hustler—that can be restarted in space, if necessary, thereby greatly enhancing the control of any launching.

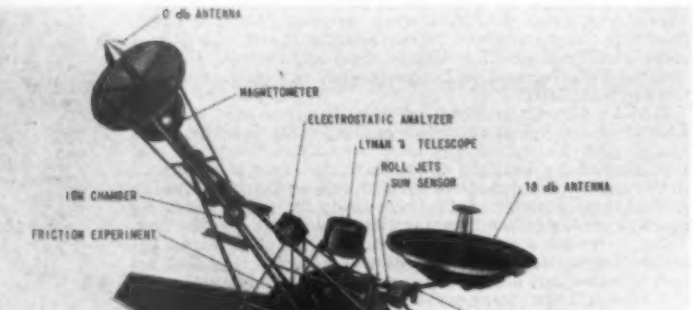
Not until the two Agena-B vehicles are available will NASA be able to lay really solid groundwork for extensive measurements in space. Dr Abe Silverstein, Director of Space Flight Programs for NASA, says the two vehicles will mark "the beginning of what we might say will be our really advanced program."

The Atlas-Agena-B will be used for unmanned studies of the surface properties of the moon scheduled by NASA in 1962. The following year the same booster combination will put specially-designed capsules containing a geophysical observatory and an astronomical observatory into orbit, while the Thor-Agena-B in 1963 will boost vehicles into orbit for further studies of the Sun's effects upon the Earth and the magnetic field around it.

Late next year, NASA is scheduled to launch its first Centaur, a multi-purpose launch vehicle that will be able to put 8,500lb into a 300-mile orbit, or to take 1,450lb up to escape velocity. Centaur will be the first vehicle to employ hydrogen as an upper-stage fuel. The first stage will be a modified Atlas, and the second stage will consist of a Centaur vehicle with two Pratt & Whitney LR115 liquid-hydrogen/liquid-oxygen engines developed primarily for space use.

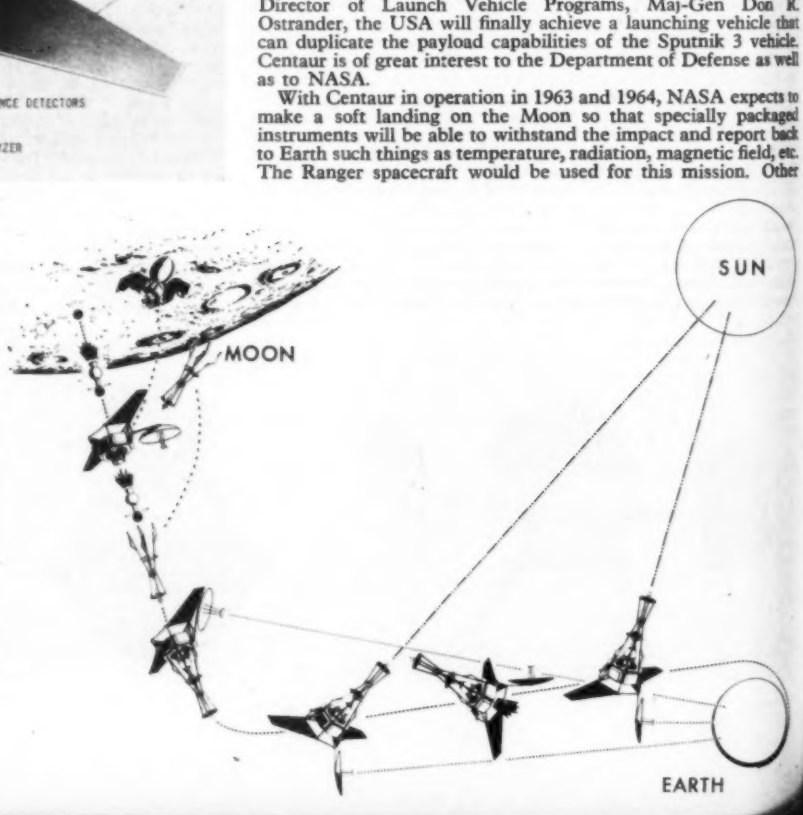
The added specific impulse of the hydrogen fuel will give the Centaur fifty per cent more payload than the Atlas-Agena-B in a low orbit, and perhaps as much as 300 per cent more payload when used as a lunar probe. With Centaur, according to NASA's Director of Launch Vehicle Programs, Maj-Gen Don R. Ostrander, the USA will finally achieve a launching vehicle that can duplicate the payload capabilities of the Sputnik 3 vehicle. Centaur is of great interest to the Department of Defense as well as to NASA.

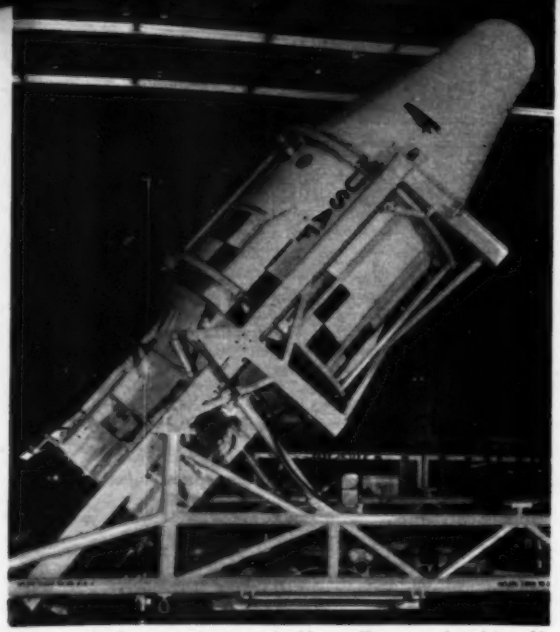
With Centaur in operation in 1963 and 1964, NASA expects to make a soft landing on the Moon so that specially packaged instruments will be able to withstand the impact and report back to Earth such things as temperature, radiation, magnetic field, etc. The Ranger spacecraft would be used for this mission. Other



Above, model of Ranger spacecraft, designed by the Jet Propulsion Laboratory for NASA. First test flight should take place next year, with Atlas-Agena-B as booster. Later, Ranger will be used on cislunar flights, for soft lunar landings, and in flights to orbit (and possibly land on) Mars and Venus, using Centaur and Saturn boosters

The diagram (right) shows how the Ranger orients itself in successive manœuvres en route to the Moon. The spacecraft first orients itself on two axes, collects solar energy from the Sun and points its directional antenna at the Earth. After radio command from Earth it leaves this position while a small rocket fires, placing the craft on an impact course to the Moon. Next it rolls and twists again on two axes to aim at the Sun and Earth once again. As it nears the lunar surface, it turns backward to take pictures of the surface and allow the capsule to be detached





At present the largest and most valuable satellites yet placed in orbit by the United States have been injected by the Agena vehicle, produced by Lockheed's Missiles and Space Division. Powered by a Bell Hustler engine, which can be stopped and started in deep space, it is used as a second stage atop Thor or Atlas boosters; 19ft long, it weighs some 1,700lb in orbit and can be made to change its attitude at will

missions will be circumlunar, to take new and better pictures of the far side of the Moon, and to make more careful studies of its surface conditions. All will be unmanned flights.

The Centaur vehicle, important in itself, has further significance with respect to US space efforts by reason of its close relationship to Saturn. A Centaur upper stage, using the hydrogen engine, will become a Saturn C-1 upper stage. Four hydrogen engines will power the Saturn C-2 second stage and one hydrogen engine will power the upper stage of the C-2.

The Saturn vehicle is meant to put very large capsules and Ranger spacecraft into orbit around Mars and Venus in the 1965-1967 period. It also will be used to effect precision soft landings on the Moon, and provide the means for returning samples from the surface of the Moon.

Following Saturn is the Nova concept to send manned expeditions to the Moon or to the planets. It would employ the new 15 million pound thrust F-1 engine, currently being developed for NASA by the Rocketdyne Division of North American Aviation. For a manned Moon expedition, able to return to Earth, Nova would employ six F-1s in the first stage. If the lunar return capsule weighed as much as 10,000lb, it is estimated that as many as four Centaur-type or larger hydrogen stages would have to be piled on top of the first stage of Nova.

Nova will not be available until sometime after 1967, according to published NASA schedules, though the F-1 engine will be ready well before that time if all goes well. Test facilities for the F-1 already are in place at Edwards Air Force Base in California, and they have been built to accommodate single, paired and quadruple combinations of this huge powerplant that will generate 1.5 million pounds of thrust.

While NASA has a clear franchise as the principal US agency for space research, it does not have a monopoly. The Air Force, Navy and Army have space programmes of their own. When the Defense Department's Advanced Research Projects Agency dropped out of sight last year the Air Force was assigned the booster programme for all of the armed Services as well as for some NASA projects, and it took over the development of the reconnaissance and early warning satellites Midas and Samos. The US Navy was assigned the navigation satellite, which is the Transit series, and the Army got the Courier active communications satellite.

Of the various military programmes, perhaps the most successful to date is Transit. Transit 1, launched last September, failed to enter orbit, but Transit 1B, a 265lb vehicle launched on April 13, 1960, went into an orbit good for several months. Transit 1B has been used as a picture-taking weather satellite. More important, Transit 2A, a 223lb vehicle, was established in a good orbit on June 22, 1960, and is expected to remain in space some 50 years as a result of an orbit that is 400 to 490 miles above the earth.

Transit 2A is exceeding performance expectations largely because of a new solar-cell array that is operating in conjunction with nickel-cadmium batteries. The telemetry system also is new and provides an FM/PM channel independent of the Doppler transmissions. With an independent PM telemetry link, a greater bandwidth is available for longer periods of time to transmit more data.

A galactic noise receiver, developed by the Defence Research Telecommunications Establishment in Ottawa, Canada, also rides in the Transit 2A package. Its measurements of galactic noise at different frequencies will be used later in making radiosonde measurements from above the ionosphere.

US Navy spokesmen say they are astonished by the accuracy of Transit 2A, and they are sufficiently encouraged to say their navigation satellite programme now is well ahead of schedule. The next launching of a Transit satellite, scheduled for this fall, is expected to allow limited use of the system by commercial ships at sea. A fully operational system, perhaps involving four Transits, may be ready sometime in 1961. Four Transits properly placed in orbit will be enough for one of them to pass within range of a ship's radio receiving equipment every 15 minutes.

Launched simultaneously with Transit 2A was a "piggyback" satellite weighing 40lb and designed by the Naval Research Laboratory to measure solar-generated X-rays and Lyman-alpha ultraviolet radiation. The Navy has dubbed it the "Greb."

The USAF Discoverer programme, which got under way last year, is aimed at putting a research and development satellite into a stabilized polar orbit, and the recovery of a capsule to be dropped by the satellite. About a dozen tries have been made, but so far no capsule has been recovered.

The programme calls for the eventual recovery of mice and monkeys from a capsule. An aircraft would snatch the capsule from the air as it parachuted down, or it would be recovered from the sea. The Discoverer launch vehicle is a Thor-Agena-A for the present. Later, the Agena-B will be used as second stage.

The Midas satellite, intimately related to the Discoverer programme, is a research and development device intended to give the USA an early-warning capability with respect to Soviet missiles. Established in a polar orbit about 300 miles above the Earth, Midas will provide infra-red detection of the exhaust flames of missiles as they are launched. Midas 2 was successfully launched on May 24 this year, but an equipment failure made it impossible to test the IR scanner.

Samos has much the same purpose. Now in development and scheduled to be operational in 1963, it will be put into a polar orbit several hundred miles out from the Earth to provide continuous infra-red reconnaissance of the world.

The US Army's Courier delayed-repeater communications satellite will be launched later this year. It will accept radio messages when over one part of the world and play them back a little later upon command, when it is over another part. Under development by the Army Signal Research and Development Laboratories, Courier will be put into a 650-mile orbit by a Thor booster, and is expected to have an operational life of one year.

All three Services are interested in an active communications satellite such as Courier. Several plans are under way to come up with more-advanced active communications satellites that carry the general group name of Advent. Polar as well as equatorial orbits may be established for these satellites.

By far the most powerful space engine in the West is the F-1, rated at 1,500,000lb sea-level thrust per chamber, which is under development by Rocketdyne. It will first be fired on test stand 1-A, now nearing completion at Edwards AFB, California

SPACE SPECIAL

Britain's modest entry into space was announced at a Press conference in Church House in May last year. From the left, Sir Owen Wansborough-Jones, then Chief Scientist, MoS; Lord Hailsham, Lord President of the Council and now Minister for Science; Aubrey Jones, then Minister of Supply; Sir Edward Bullard, steering-group chairman; and Prof H. S. W. Massey, now Sir Harrie Massey, chairman of the Royal Society's space-research committee. Lord Hailsham, Sir Edward and Sir Harrie are now among those most directly involved in solving Britain's space dilemma

Britain's Space Dilemma

"THE Government have been studying the scientific, technological, commercial and other benefits which might be derived through space research, together with the cost in money and resources.

"The results of these studies are being communicated to the Australian Government, with a view to discussing with them fully all aspects of the problem. A Minister will go to Canberra for this purpose."

With these words in the House of Commons last week the Minister of Aviation, Mr Sandys, left hanging in the air both the hopes of the space enthusiasts and the fears of those who feel a large-scale space programme would be an expensive misdirection of effort. The clear implication is that the Government will go ahead with a major programme only if Australia will contribute substantially to the cost.

A second implication is that no other country, Commonwealth or foreign, has been or is going to be brought in for "a full discussion of all aspects of the problem," in spite of promises to the contrary by the Minister on several previous occasions. The lip-service to international co-operation is apparently as empty as the cynics have come to expect. This seems to be the old nationalism, and it is not in the least surprising that it has produced an almost insoluble dilemma for this country.

Over the past twelve months the views of those for and those against a major British space effort have noticeably moderated, so that there is now a much narrower strip of disagreement between the two sides. Let us consider some of the opinions that have been voiced, and the activity that is under way now.

One of the most outspoken high-level criticisms of a major space programme on a purely national basis was that of the Government's Advisory Council on Scientific Policy, presented in its annual report last December. Although, with the establishment of the Steering Group on Space Research under Sir Edward Bullard, the Council's direct concern with the space programme had in fact ended, the council members expressed the wish to "take this opportunity of setting out certain principles which we believe should underlie British participation in this exciting new field of endeavour."

These certain principles included the following argument. The USA and USSR had been pioneers in this field. Space research, especially when it proceeded beyond the launching of small satellites, must make enormous and increasing demands on scientific and financial resources, and US and Soviet activity in this field had arisen largely as an offshoot of military expenditure on ICBMs. We in Britain could not hope to provide all the resources necessary to develop space exploration independently on an equal footing with these two great nations. Scientific prestige was obtained through research which was important scientifically and was well planned and executed, and did not depend on the size or spectacular nature of the project.

"No one can deny the attraction of space research and space exploration," the report stated, "nor can it be doubted that valuable scientific knowledge will accrue from them. But the magnitude of the effort involved in a substantial programme of space exploration, both in terms of money and manpower, is so great as to put its development and operation beyond the reasonable capacity of any but the wealthiest of nations. This Council has repeatedly emphasized the importance of adequate expenditure on research and development in fields of endeavour which are vitally important for the welfare of our people and for the strengthening of our economic position, as well as for the improvement of living standards in the less well-developed countries, particularly in the Commonwealth countries and colonial territories. To leave these needs unsatisfied in order to shoulder the crippling cost of a large programme of space exploration on a purely national basis would be, in the Council's view, the grossest folly.

"Here surely is a situation in which the proper solution lies in a co-operative effort by all nations. We believe that British science and technology have much to contribute in this field and that they should do so. But these contributions should be made in specified directions appropriate to our special skills and they should be part of an internationally based approach to the whole field. We therefore consider that every effort should be made to establish such an international co-operative effort, and we particularly welcome the newly established co-operative agreement with the USA as a step toward this goal."

The Scout Programme

The co-operative programme with the USA, in its initial form, involves the provision of payload space in three satellites for British scientific research equipment. These satellites will be launched by Scout solid-propellant rockets, beginning in "the latter half" of 1961. Telemetry, satellite structure and solar power supplies will be provided by the US, amounting perhaps to 100lb and leaving (in the first example at least) some 20lb for the British scientific experiments.

The experiments to be carried in the first Scout-launched "International" satellite are those recommended by the Royal Society's National Committee on Space Research, approved by the Bullard Steering Group, and described in *Flight* of February 12 last. The choice of experiments was outlined by Prof Massey, chairman of the National Committee, along these lines:—

Most of the scientific groups concerned should have had experience in the Skylark programme so that most of the experiments would be appropriate modifications of similar investigations in that programme. It was also important that an experiment should not duplicate work already done by US and Soviet scientists, but should take advantage of any special experience possessed in this country.

A natural choice for the core of the experimental programme was the direct study of the electrical properties of the ionosphere. Sir Edward Appleton, FRS, was a pioneer in the study of the ionosphere from the ground, and ever since then British scientists have played a leading part in this work.

Two research groups, one under Prof J. Sayers at the University of Birmingham and the other under Dr R. L. F. Boyd and Dr A. P. Willmore at University College, London, have been developing the techniques for laboratory study of ionized gases like the ionosphere for some years. Both groups have applied the experience gained in this way to carry out successful ionospheric observations with instruments in Skylark rockets. Three of the experiments in the first Scout vehicle are based on these earlier investigations.

In one set of experiments, Dr Boyd's group will measure the concentration and mean energy of the electrons in the ionosphere. From the mean energy the temperature may be determined. The same group will also determine the nature of the positively charged atomic fragments (positive ions) in the ionosphere. This is designed to follow the variation in composition of the high atmosphere, presumably mainly atomic oxygen, as it merges into

interplanetary space in which the main constituent is hydrogen. Prof Sayer's group will measure the electron concentration by a different method to provide a useful check on these results.

The ionosphere is subject to control by the Sun and it is therefore desirable to observe simultaneously with the properties of the ionosphere the intensity of the solar radiation which is influencing it. Dr Boyd's group are therefore including equipment in the form of suitable counters to measure the intensity both of the X-rays and of certain ultra-violet radiation from the Sun.

Finally, an experiment is to be included which is designed to measure the intensity of the heavy component of primary cosmic rays. This will be the responsibility of Dr H. Elliot's group at Imperial College, London, who have carried out many important ground-based studies of cosmic radiation in the past. Dr Elliot hopes to obtain information about the nature of the magnetic field experienced by the cosmic rays.

Too Narrow a Field?

Objections raised to the Scout satellite programme were not on the grounds that it would not achieve valuable scientific results, but that science itself was too narrow a field against which to measure the implications of space research. At that time the Government's Steering Group—which at no time could legitimately be accused of having a narrow outlook—was deliberating whether, in addition to using Blue Streak as a long-range ballistic missile, Britain should afford it for space use on the back of the military programme.

In February this year a leading article in *Flight* pointed out that "the official climate has changed within the past nine months, and has become distinctly favourable to the idea of using Blue Streak/Black Knight boosters for space research. The intuitive belief has grown that this will in fact happen." Before this had time to happen the Blue Streak missile was cancelled, and we were back to square one with a new set of cost figures being produced for the Minister of Aviation by de Havilland, Rolls-Royce, Sperry, Saunders-Roe and the Royal Aircraft Establishment.

During the months since the Blue Streak cancellation the supporters of an all-British space programme have increased the pressure. Obviously it is now a matter of absolute urgency, no longer just a pleasantly desirable and profitable extra, to the engineers of the Blue Streak team, for example, the people most directly concerned.

It has fallen to the British Interplanetary Society to become the semi-official voice of the Union-Jack-in-space protagonists. In its various calls for action and published memoranda many valid points have been made, but the Society inevitably loses in effectiveness because of its mixed membership. To say this is not to attack the BIS, but simply to face facts and admit that an organization which includes schoolboy enthusiasts for interplanetary travel—notwithstanding the senior rocket engineers who are also members—should not be surprised when its views do not command quite the authority of those of Fellows of the Royal Society. Neither, incidentally, is the cause advanced by clever questions in the House which begin "Does the Minister realize that many scientists and engineers of a practical nature, as distinct from those members of the Royal Society who advise him, are extremely worried that . . ." (Woodrow Wyatt, February 15, 1960).

But the British Interplanetary Society, in spite of itself, has at least endeavoured to examine the problem in its widest sense, and to put forward a number of well-thought-out suggestions. The society's most recent presentation was an extremely full memorandum, *Participation of the UK in Spaceflight Development*, published last month.

After dealing in turn with "The Urgent Challenge of Astronautics," benefit from a space programme, and the US programme, the memorandum considers what Britain could do. It is worth quoting this section almost in full:

"It will be fully appreciated [the memorandum states] that the UK cannot possibly hope to compete on equal terms of expenditure and diversity of projects with the USA (or USSR). To assume, however, that we can therefore play no significant part at all, would be a betrayal of our national future. The installation of British instruments in American satellites is a step in the right direction, but cannot be regarded as constituting a 'significant part' in this sense.

"The possibility of using Blue Streak and Black Knight as a two-stage satellite launching vehicle has been seriously proposed in many quarters. The payload capabilities of such a launching vehicle would be in excess of 1,000lb for a close Earth satellite orbit.

"This is an obvious and vital first step for a British space programme. At the time of the cancellation of Blue Streak as a weapon, about £65m had been spent on its development, including the development of the Black Knight test vehicle and the engine test beds at Spadeadam. To complete Blue Streak as a launching vehicle would cost (say) £45m, and the cost of adding Black Knight as a second stage might be estimated at £20m. Thus Britain could have available a space launching vehicle, comparable with those currently available in the USA, at a further cost of the order of £65m—little more than a tenth of the estimated total cost of the original Blue Streak weapon system . . .

"While stressing the immediate need to continue with the present development of Blue Streak as a launching vehicle, very careful consideration must be given to the subsequent programme. The main items of the space programme suggested herewith, would be as follows:—

(a) A definite project to develop Blue Streak and a modified Black Knight as a satellite launching vehicle. This would be in addition to the expansion of existing work on satellite tracking and orbit analysis, and a vigorous prosecution of the project to launch British instruments in the American Scout rockets.

(b) A later project to develop improved and more powerful second and third stages for a modified Blue Streak. This could at least double the payload of this vehicle.

(c) A detailed feasibility study of communications satellites, including an examination of their commercial and military significance.

(d) The design of equipment and techniques for communication, telemetry and navigation in space, including the provision of power sources.

(e) A gradually developing programme of research on hypersonic winged vehicles and their use for controlled re-entry into the atmosphere.

(f) A modest programme on space medicine, i.e., on the problems of Man in space.

(g) A programme of research and development on new propulsion systems, such as the nuclear rocket and electrical (ion and plasma) rockets, possible synthetic metastable propellants of great energy (based on "active" atomic species, etc.). This would be a very long-term programme, developing gradually over the next decade or more.

"On the initial assumption that Blue Streak is continued as a satellite launcher, it is believed that a significant programme as outlined above could be made for a further annual expenditure rising within five years to £20m and being maintained thereafter at this approximate level. The corresponding deployment of technical manpower (in addition to the Blue Streak teams) would rise to about 1,000 graduate scientists and engineers (drawn from a variety of disciplines), with supporting technicians, industrial labour and facilities."

A further significant suggestion by the BIS is that "we should recognize the new trend in Europe from the start and think in terms of a European space project rather than a UK programme."

Uneasy Period of Waiting

And now the ball is back in the Government's court, with Members of Parliament away for a three-month recess and a decision unlikely before November. In this uneasy period of waiting, what space-research activity is going ahead in Britain?

The engineering design of the Scout satellite payloads are occupying the University groups, and (to a small extent) the electronics industry. The RAE is looking further ahead than this to larger satellites, as are industry groups such as the astronautics section of Hawker Siddeley Aviation's Advanced Projects Group at Kingston, where a considerable amount of design and calculation work has gone into communications satellites, reconnaissance satellites and their orbits. The industry's rocket-engineer teams, it seems, can only sit and wait—and hope.

Only in the field of tracking and communicating with satellites and probes, and analyzing such data, is the picture rather brighter. Jodrell Bank's most recent achievement, before the big dish adjourned for a well-earned overhaul, was to keep in radio touch with Pioneer 5 to a distance of 22.5 million miles. The operation of this capable establishment was described in *Flight* of August 28, 1959.

This year has seen a swing in emphasis towards space affairs at the DSIR Radio Research Station at Slough, with a broadening of the Station's terms of reference and the start of construction work on the new Minitrack station at Winkfield. Full details are given in a special article on page 186.

This, then, is an indication of Britain's space dilemma. Nobody is under the illusion that the answer to the problem is an easy one although once again, in the weeks before Parliament adjourned, the impression had gained ground that the Government would decide in favour of a major programme.

The danger here is that this country may decide to embark on such a project for the wrong reasons. Already there is evidence, as noted at the beginning of this article, of an apparent failure to tackle the problem in the most realistic way, i.e. with full Commonwealth and European co-operation *from an early stage*.

It is now some time since the Cabinet received the recommendations of the Bullard Steering Group and the advice of the Minister of Science. The other interested Government departments have also given their views. There is still time to obtain the right answer.

Amid all the detailed talk of what might be done in space, and how it might be achieved, there has remained a confusion of reasons given in reply to the question "Why do we want to do this?" The Government's problem might be more easily answered if Ministers went back to first principles and got this point absolutely clear. It is far from clear at present.

KENNETH OWEN

SPACE SPECIAL

BRITAIN'S BOOSTER

LAST week's statement (page 182) by Mr Sandys made it clear that it will be some little time before the Government feels able to issue a public statement on Britain's future in the space age. One thing, however, is quite obvious: if we do decide to "have an adventure in space," it is sure to be on the back of Blue Streak. This long-range ballistic missile was first announced by the Minister of Defence in August 1957. Its cancellation as a military weapon was announced last April—for reasons which need no repetition here.

To a considerable degree the design of Blue Streak has benefited by experience with the Atlas ICBM, and with the blessing of the US Defense Department much classified knowledge has been passed by Convair, Rocketdyne and other companies to the team charged with the development of the British weapon. (We might add that there has been a corresponding reciprocal flow to America.) The latter is led by de Havilland Propellers Ltd, who are responsible for management, assembly and test, and includes de Havilland Aircraft for the airframe, Rolls-Royce for propulsion and Sperry for guidance. Structurally the airframe is a logical extension of the stainless-steel "balloon" monocoque developed for Atlas, although rather more of the British vehicle is stabilized by axial corruguations. Propulsion is effected by twin gimballed chambers, each probably rated at some 150,000lb at sea level on liquid oxygen and kerosine and flanked by a prominent stackpipe from its associated turbopump.

Design range of this basic vehicle has always been assumed to be of the order of 3,000 miles, carrying a typical thermonuclear payload weighing several thousand pounds. Used in conjunction with suitable upper stages, Blue Streak is obviously a booster of considerable capacity, and one which might show singular advantages over most other militarily-derived vehicles in the West. Not only have D.H. Propellers made various proposals for second and third stages, but the RAE have for many months been engaged in detail design studies. Most of these investigations are predicated on the assumption that the second stage would either be Black Knight or a modification of this exceptionally reliable vehicle.

Mating Blue Streak and Black Knight could be done for a very modest sum. The detail design has been virtually completed, and very little need be done to make such a marriage a *fait accompli*. The resulting vehicle would be able to place a payload of about 1,000lb in a 300-nautical mile Earth orbit, sufficient for a wide variety of missions. However, the existing Black Knight is far from being the optimum second stage. Its high fineness-ratio would impose structural penalties near the junction with the booster, and might make the vehicle unwieldy on the launcher (in high winds for example). Moreover, the Blue Streak and the unmodified Black Knight are not perfectly compatible in performance.

As was first outlined in our issue of September 11, 1959, de Havilland Propellers have prepared a design for an optimized two-stage combination, in which the second stage consists of a modified Bristol Siddeley Gamma engine fed with propellants housed within a spheroidal tank which, although much shorter than that of the original Black Knight, would have greater capacity. The HTP and kerosine would be separated by a cylindrical diaphragm which makes for a very efficient structure. As the accompanying drawing indicates, small HTP nozzles would be incorporated to provide attitude control and assist in the regeneration of the propellants after coasting at zero g.

Although the powerplants are essentially unchanged, this repackaged second stage matches the first stage so closely that the resulting combination would have approximately double the performance of the unmodified scheme. Calculations show that it should be able to place a payload of the order of 2,000lb in a 300-n.m. Earth orbit, and proportionately smaller or greater payloads along other trajectories.

Thus, the Blue Streak and modified Black Knight form a combination with an overall capability greater than that of the Sputnik 1 vehicle and all the American first-generation launchers. It is not, however, able to match the performance of Atlas-Agena, Centaur or the Soviet multi-stage rocket which launched Sputnik 4; Britain has so far announced no plans for the development of more-advanced boosters and has no experience at all of large engines running on liquid hydrogen. Nevertheless the two vehicles illustrated opposite could perform nearly all the military, scientific and commercial missions which currently seem to be of interest, and it is possible to cast a brief look at some of the things that might be attempted.

Scientific From what one can gather, the former Minister of Aviation, Mr Duncan Sandys, has devoted most of his spaceflight energies towards the fulfilment of purely scientific requirements. The possibilities are limitless. Even the Astronomer Royal—no lover of science fiction—has spoken with some enthusiasm of the improved photographs of the Universe which could be obtained with the aid of a telescope stationed above the Earth's atmosphere. Most of us are so used to living on the Earth's surface that we tend to forget the potency of the atmosphere as a filtering medium; and, although it forms a blanket without which we should die, it cuts off a vast range of electromagnetic wavelengths and introduces distortions and aberrations which are difficult to measure. The British two-stage vehicle could undoubtedly carry a telescope, photographic system and print transmitter which could enable "true" pictures to be obtained.

At the same time, the efficacy of the atmosphere as a blanket has made astronomers long wish for a space-located observatory which could investigate infra-red and ultra-violet "sources" with the same accuracy that radio astronomy can now be conducted from the Earth. At present astronomers do not even know exactly what they are missing, since the absorption spectrum of the atmosphere has not been precisely determined, and in any case it is impossible to infer the existence of something from its absence. Other investigations which teams in Britain are already discussing involve geomagnetism, cosmic rays, the Van Allen belts and simple plots of density, temperature and other basic parameters.

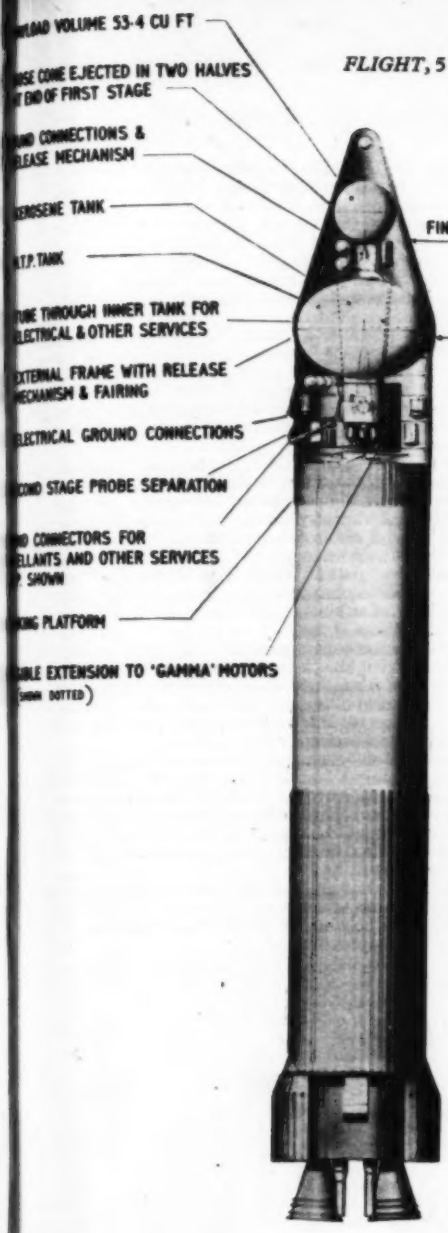
Commercial The possibility that adventures in space might yield lucrative returns is undoubtedly a significant factor in deciding whether Britain should "have a go" or not. He would be a bold prophet who would risk all his capital in so uncertain a field, but in many areas it can be shown on paper that likely returns exceed the likely expenditure.

In the field of communications, for example, the Postmaster-General has already been drawn into discussing the relative merits of submarine cable systems and communications satellites. The latter need to be thrown into a very high, ellipitic orbit, and although the required trajectory would cut the payload to much less than 2,000lb, the available weight would still be ample for a useful orbiting vehicle. Launch times and dates would need to be so chosen as to ensure that any such satellite spent the maximum part of its life in sunlight, since solar cells would doubtless be used to provide the internal power necessary. A series of six satellites would provide global voice communications over a large number of channels, and it would be strange indeed if the British electronics industry was not able to achieve an adequate signal: noise ratio and reliable performance within the limitations of size and weight imposed.

Owing to the Earth's oblateness, the plane of a satellite's orbit rotates, and the orbit also rotates within this plane (the apogee/perigee diameter precesses). For a communications satellite it is desirable that these variations should be minimized, and it is possible to eliminate them without propulsion in orbit by carefully launching into an orbit which makes an angle of about 63° with the plane of the Equator. A similar orbit would probably be chosen for a navigation satellite.

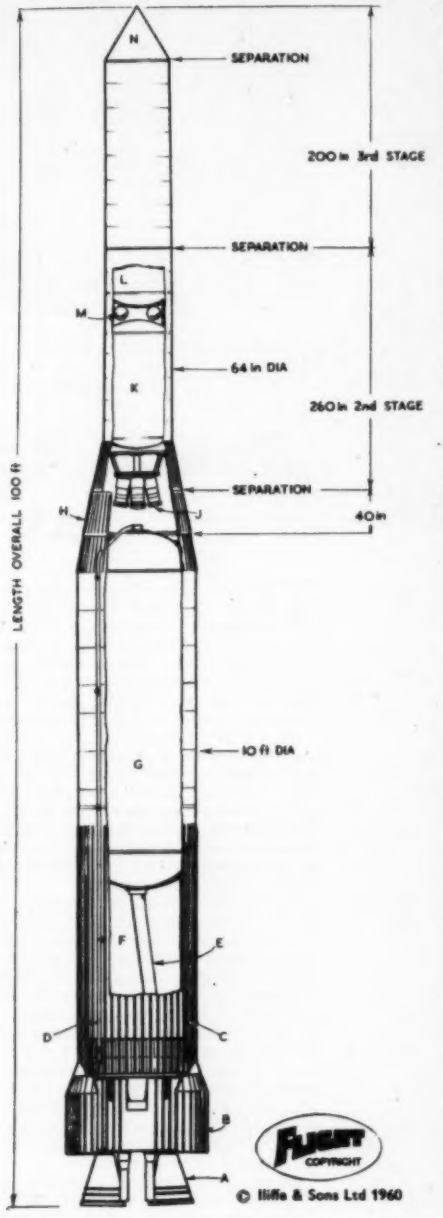
This would, in effect, merely provide another heavenly body upon which mariners (and possibly aircrew) could practice astro-navigation. It could be a purely passive (i.e., not transmitting) object, and should ideally be placed in a low orbit—300 n.m. would give an adequate life. One such satellite would give a position line, and two a running fix. There would be no payload limitation, and the space above the modified Black Knight would

Manager of the Project Office at de Havilland Propellers Ltd concerned with spacecraft based on Blue Streak is G. K. C. Pardoe, seen here with models of the original ballistic missile and of a suggested second stage based on Black Knight


LOAD VOLUME 53·4 CU FT
NOSE CONE EJECTED IN TWO HALVES AT END OF FIRST STAGE
GROUND CONNECTIONS & RELEASE MECHANISM
KEROSENE TANK
H.T.P. TANK
TUBE THROUGH INNER TANK FOR ELECTRICAL & OTHER SERVICES
EXTERNAL FRAME WITH RELEASE MECHANISM & FAIRING
ELECTRICAL GROUND CONNECTIONS
SECOND STAGE PROBE SEPARATION
GROUND CONNECTORS FOR PROPELLANTS AND OTHER SERVICES NOT SHOWN
LAUNCHING PLATFORM
FLEXIBLE EXTENSION TO 'GAMMA' MOTORS (SHOWN DOTTED)
FINAL SEPARATION
SEPARATION LINE

The drawing on the left was prepared by de Havilland Propellers and published in a recent paper read before the Royal Aeronautical Society by Mr Pardoe. The second stage is the "squashed" Black Knight seen in the illustration opposite in model form, but the basic booster appears to be virtually identical with the Blue Streak LRBM

Another possible space vehicle system could be this combination of Blue Streak and second and third stages having cylindrical tankage for HTP and kerosine in tandem, yet shorter and fatter than Black Knight. The dimensions given are approximate, and the key is: A, Rolls-Royce gimbal-mounted chamber; B, skirt fairing; C, external pipe fairing; D, liquid-oxygen filler pipe; E, liquid-oxygen delivery pipe; F, kerosine fuel housed in corrugated tank; G, liquid oxygen housed in pressurized tank; H, transition section; J, modified Bristol Siddeley Gamma engine; K, HTP tank; L, kerosine tank; M, gas bottles; N, fairing over payload



be very suitable for the stowage of something which could be unfolded or inflated to give an enormous visual or radar cross-section.

In the field of meteorology, which could also have been discussed under the "scientific" heading, it is probably fair to state that we are on the brink of finding out how the atmosphere really behaves. Without wishing to conjure up mental pictures of crystal balls and seaweed, the fact remains that meteorologists have in the past been able to do no more than study an existing situation and forecast what is likely to happen on the basis of previous experience. Nobody today knows why a region of high pressure comes into being, nor why it behaves exactly as it does. Already the Tiros has produced remarkable photographs of cloud cover, and the two-stage British vehicle could undoubtedly place in orbit equipment of a more sophisticated kind. It is not entirely facetious to suggest that the United Kingdom would be peculiarly able to benefit from a better understanding of why we get the weather we do.

Military There has been no official suggestion yet that this country has a military requirement extending into space, but it would be strange if studies on paper were not being made. Unlike a civil space programme, which could be conducted with very reliable guidance systems based on an autopilot and command radio, military launchings would have to be guided by a system which could not be interfered with. Even a vehicle launched from Woomera and guided by command signals might be jammed by a lurking submarine, and at present all-inertial guidance would appear to be mandatory. Most kinds of military space mission could be handled by the combination here considered, and Britain would appear to be likely to devote particular attention to defensive systems, including early warning against ballistic missiles and reconnaissance by photographic radar and infra-red techniques. It is appropriate in discussing such missions to observe that the Bristol Siddeley Gamma engine should be quite capable of being started in outer space; there should be few ignition problems and, to an outside observer, it seems that the only factor to worry about is how to keep the liquids on the floor of the tanks.

Looking Ahead The stipulated payload of around 2,000lb means that the British vehicle could undoubtedly place a man in a low Earth orbit. Such an exercise would not be undertaken until all of the hardware involved had been thoroughly proven, but it might be accomplished by about 1964. Much earlier, the Blue Streak and modified Black Knight could place a small payload on the face of the Moon. By "small" we mean appreciably more than a Union Jack, and probably something measured in tens of pounds.

It is not proposed here to dwell on the subject of costs. Suffice to say that from the technological viewpoint there is no barrier at all to the accomplishment by the British Commonwealth—completely independent of other countries, if need be—of all the missions outlined above. But if we decide to stay in the atmosphere we shall very soon cease to have this ability.

"Flight" photograph

Director of the Radio Research Station is Dr R. L. Smith-Rose (centre). His three Division heads are Dr H. G. Hopkins (left), Dr J. A. Saxton (right) and Mr A. F. Wilkins

Space Research at Slough

THE decision to expand the space-research interests of the Radio Research Station at Ditton Park, Slough, and ultimately to have some 50 per cent of the staff involved in this subject, is resulting in two major effects. On the one hand satellite techniques are providing a fuller knowledge in fields which have traditionally been studied by the Station, while in addition there are now new fields to explore, new equipment to devise and operate, and new observations to be made and analysed.

For many years most aspects of the work of the Station, which is a Department of Scientific and Industrial Research establishment, have been concerned with the propagation of radio waves. The properties of the ionosphere have been studied, together with radio-wave propagation over long distances (including back-scatter techniques and fixed-frequency and sweep-frequency pulse transmissions), the physics of the ionosphere and a considerable amount of tropospheric work. Both atmospheric and cosmic radio-noise has been investigated.

The use of artificial Earth satellites carrying radio transmitters has obviously opened up much wider possibilities in these studies. The ionosphere can be investigated from above, making even the highest layers accessible, and also from "inside" in the case of orbits which pass through the ionized layers.

Under the Director of the Station, Dr R. L. Smith-Rose, the RRS operates in three main Divisions, headed by Dr H. G. Hopkins, Dr J. A. Saxton and Mr A. F. Wilkins. Each Division in turn comprises a number of smaller working groups, and it is one of Dr Hopkins' groups, led by Dr B. G. Pressey, which is concerned specifically with satellites and space studies. The new types of work which have come to Slough since the advent of satellites are mainly concentrated in this team, although the influence of the new techniques is steadily permeating the work of the other groups also.

At present Dr Pressey's satellite group contains approximately 20 people, or about one-tenth of the total staff of the Station. Their main activities are: (1) the tracking of satellites, mainly by radio but also optically. The major facilities for this are three interferometer installations, operating on 20, 40 and 108 Mc/s at Winkfield, south-west of Windsor.

(2) prediction of satellite positions, based on the Station's own observations, Russian and US data, and observations from individuals and observatories in Britain, other European countries and as far afield as Woomera and Japan. As described in *Flight* of April 29, 1960, these predictions are issued weekly to interested observers. The prediction service was assigned to Slough in October 1958; previously it had been handled by the Royal Aircraft Establishment and, earlier, by the Nautical Almanac Office. The men who make the predictions at RRS also study the variations of orbits, and so obtain information on satellite lifetimes and air drag.

(3) extracting further information from radio signals transmitted by satellites. From the Doppler frequency shift further tracking data can be obtained and, given the appropriate telemetry codes and calibrations—as were provided by the Russians for Sputnik 3 and the US for Explorer 7—the recorded telemetered data can be analysed. Cosmic-ray intensities transmitted by both satellites were obtained in this way.

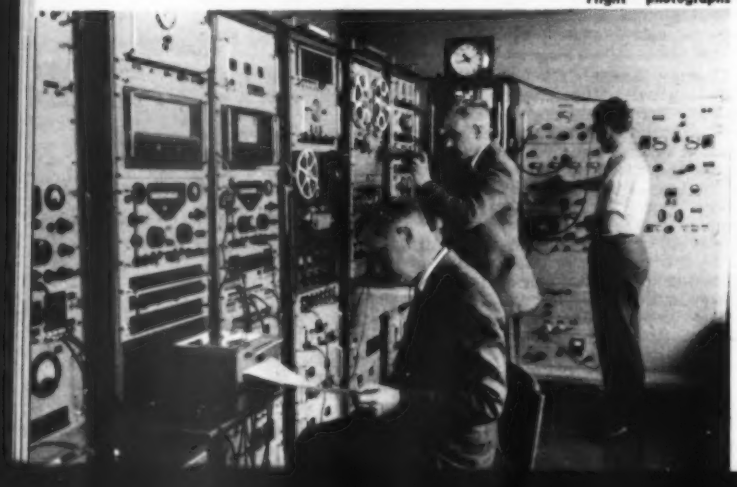
(4) operating World Data Centre C for Rockets and Satellites. Slough is one of the three such centres established during the IGY to collect accurate positional observations, computed elements of satellite orbits, reduced telemetry results and reports of investigations. The other centres are in Washington and Moscow, and each centre issues periodically catalogues of data held. At present the "rockets and satellites" part of World Data Centre C consists of the contents of a few filing cabinets only, sharing a large room with the many microfilm cabinets comprising the ionospheric section of the centre.

(5) carrying on the Station's main research programme, perhaps the most important aspect of all. Some of this arises from analysis of the signals received in (1) and (3) above, and from comparison with theory and with optical observations, with the overall objective of learning as much as possible concerning the propagation of radio waves through the ionosphere from satellites.

The most recent RRS development is the provision of a US Minitrack station for satellite tracking and telemetry reception at Winkfield, by agreement with the National Aeronautics and Space Administration. This is now under construction. All equipment will be supplied by the USA and the station will be operated by RRS personnel. Another facility which is planned is a 60ft diameter radio telescope.

The present time is one of gradual transition at Slough, with new ideas being grafted on to the old. Although not actively working on hardware for any of the British Scout payloads yet announced, the station has an obvious interest in the radio aspects of such work.

The satellite-prediction team keeps track of all artificial Earth satellites passing over Britain and provides orbital details for observers



Radio signals from satellites are here received and recorded for later analysis. Seated is Dr B. G. Pressey, head of the satellite group

"Flight" photographs

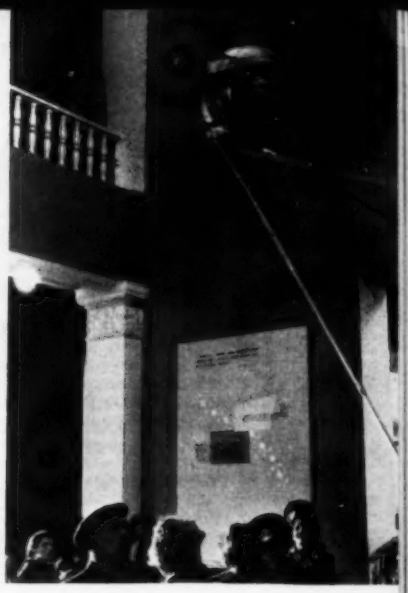
The past history of the station is not confined to its basic research and applied investigations, which have taken up approximately equal amounts of effort, but has included continual collaboration with a variety of other Government departments. This would clearly be called upon in any possible more-advanced British satellites which might be designed for communications, meteorology or navigation.

In the immediate future, in connection with the reception of telemetry from the first British Scout satellite, the establishment's sub-station at Singapore will be increasingly active. It is hoped to establish there a new site with interferometers operating initially on 20, 40 and 108 Mc/s.

Up to the present time, the Radio Research Station has concentrated on making good use of other countries' satellites, and has not seriously concerned itself with payloads. Within a year or two, the scope of space research at Slough may be quite different.

Placings in the Space Race

SOVIET AND AMERICAN ACHIEVEMENTS COMPARED



It all began with Sputnik 1 on October 4, 1957. Here a full-scale replica of the world's first artificial Earth satellite is displayed at a Moscow exhibition

IN the year 1960 launchings of artificial Earth satellites are commonplace news-items. The wonder of October 1957 and Sputnik 1 has changed to a casual acceptance of all but the most spectacular of space achievements. To receive more than passing attention, those in the space race must hit the Moon, take close pictures of it, or send up two satellites for the price of one.

In this situation it is difficult to know, or to remember, exactly what are the significant respective achievements of the two contenders, although one may have the vague feeling that if something really big happens the news will most probably come from Moscow and not Washington. On the other hand, this month's Earth satellite, marking a modest but definite advance, will probably be American—and that goes for last month and next month.

The Administrator of the National Aeronautics and Space Administration, Dr Glennan, expressed this point earlier this year as follows: "A comparison of the results obtained in the two programs makes clear the preponderance of spectacular 'firsts' achieved by the Soviet Union, while our own program has yielded less spectacular, but on the whole equally or more significant, scientific results."

Concerning the underlying reason for the more-spectacular Soviet achievements, Dr Glennan said: "Based on their substantially earlier start in the development of large rockets, Soviet scientists have had at their command a rocket which our scientists and engineers estimate is in the 600,000 to 800,000lb-thrust range. They have spoken of multi-stage launch vehicles, and some of their mission accomplishments would indicate that they have used upper stages with these very powerful first-stage rockets. Undoubtedly they are continuing to refine and optimize their present units while developing even more powerful rockets and launch-vehicle systems.

"This disparity in thrust enables the Soviet Union to undertake difficult space missions, some of which are completely denied to us today. It is reasonable to assume that the Russians can move more rapidly from concept, to drawing board, to the construction and launching of payloads because they are not limited by the weight restrictions we are experiencing. I suspect that they can avoid the time-consuming business of miniaturization, optimum packaging, and other weight-saving practices. Moreover, their ability to carry heavy payloads improves the probability of success in any particular experiment because they have adequate weight-carrying margins to permit the employment of redundancy or duplication in many elements of their guidance, control and communications sub-systems."

Whatever the reasons, the broad results are indicated in the table on page 189 (in conjunction with the earlier table printed in *Flight* of August 28, 1959). The satellite scoreboard to date shows a total of 26 artificial Earth satellites successfully launched, of which 21 have been American and five Russian. Of these, eleven US satellites and one Russian are still in orbit, and seven of the American types are still transmitting data.

Three deep-space probes have been launched successfully by the Soviet Union, each of which achieved its principal stated objective. One is in orbit around the Sun, the second continues in a highly elliptical orbit about the Earth, and the third made a hard landing on the Moon. Two of the four US probes successfully launched, Pioneers 4 and 5 "substantially" achieved their objectives and are now in solar orbit.

The accompanying tables are based on information given in *US and USSR Space Science Results*, a NASA paper by Dr Homer E. Newell Jr, Assistant Director, Space Sciences, with the addition of more recent data. In any attempt to compare the relative stages of advancement of the American and Soviet space-research effort, Dr Newell suggests, the most effective method is to isolate the general areas of investigation.

"Taking this approach, one can say that the US and the USSR appear to be at about the same stage of advancement in upper-air research. The US results on the atmosphere below 200 miles appear to be more detailed and complete, but the Soviets have made higher-altitude measurements by means of their geophysical rocket. The Soviets appear to have done far less than the US on solar radiations, but the USSR has done much more than the US in biosciences experiments, having conducted numerous flight tests in which dogs were carried aloft in rockets and safely recovered. The USSR has carried the technique of ejecting instrumented packages from the rocket carrier farther than has the US, which has carried the technique of telemetering to a high degree of refinement.

"Likewise, the US and the USSR seem to be at about the same

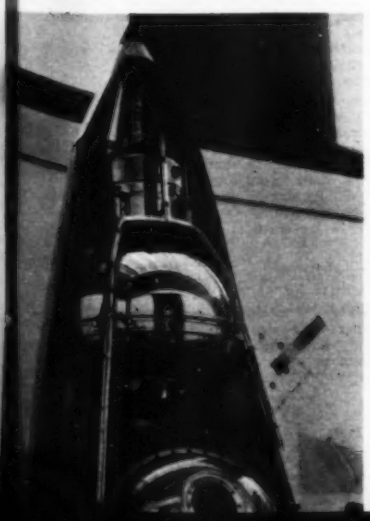
Significant Firsts in Space Research

UNITED STATES

1. A number of firsts in high-altitude rocket research, including: first detailed photograph of solar ultra-violet spectrum; first photograph of complete tropical storm; first penetration of equatorial ionospheric current sheets; first detection of X-rays in high atmosphere; first detection of auroral particles in high atmosphere.
2. Discovery of the Van Allen Radiation Belt.
3. Discovery that the Van Allen Radiation Belt consists of at least two zones.
4. Performance of the Argus experiments.
5. The first precise geodetic use of artificial Earth satellites to obtain refined information on the size and shape of Earth, providing an improved value for the flattening and showing that Earth is actually slightly pear-shaped.
6. First achievement of an elementary communication satellite.
7. First cloud-cover photographs of Earth from satellite.
8. First demonstration of feasibility of satellite navigation system.
9. First launch of two separate satellites by one launch vehicle.
10. Radio communication with probe up to 22.5m miles from Earth.

SOVIET UNION

1. First artificial Earth satellite.
2. First lunar near-miss.
3. First lunar impact.
4. First pictures of far side of the Moon.
5. First detection of what may be a current ring about the Earth (the Chapman-Størmer ring).
6. First routine recovery of large animals (dogs and rabbits) from high-altitude rocket flights.
7. Development and routine use of a meteorological sounding rocket, recoverable and re-usable.
8. First launching of a large animal (dog Laika) in an Earth satellite.
9. First high-capacity, manœuvrable, heavily instrumented spacecraft with fully successful long-range communications.
10. First satellite to contain cabin fully pressurized and equipped for manned spaceflight.



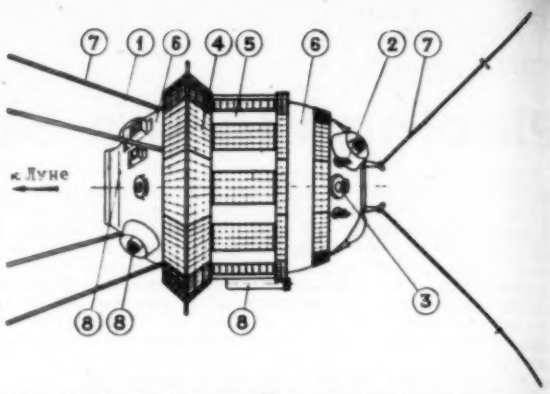
Cutaway nosecone and main components of the Soviet Sputnik 2, which carried the dog Laika (in lower compartment) into orbit around the Earth in November 1957

Placings in the Space Race . . .

stage of advancement in studies of the Earth's environs where satellite techniques are adequate for making the necessary observations. In fact it may be that in this regard the United States has the slight edge. The big advantage the Soviets have in attacking these problems lies in their greater payload capacity. On the other hand, the United States has launched many more satellites than the Soviet Union."

The undoubted lead held by the Soviet Union in deep-space probes is directly attributable to their commanding position in vehicle technology. As the second table indicates, the scientists of both countries are at roughly equal stages of advancement in the space-research problems now being studied.

The NASA scientist concludes: "The side that has the more advanced technology in the way of payload capabilities, guidance, etc., will have the distinct edge and by virtue of the increased flexibility and capabilities provided by the more advanced technology will forge steadily ahead. Thus, one may predict a time lead in vehicle technology will be transformed into a corresponding time lead in the exploration and investigation of outer space."



Among significant Soviet "firsts" was the Lunik 3 achievement of photographing the far side of the Moon and relaying the pictures to Earth. This drawing of the probe shows (1) window for camera, (2) orientation system motor, (3) solar monitor, (4) solar battery section, (5) heat-regulation shutters, (6) thermoscreens, (7) aerials and (8) cosmic research equipment

PROBLEMS CURRENTLY UNDER ATTACK

Field	United States	Soviet Union
Upper Atmosphere	(1) A detailed study of the structure, winds, and composition of the ionospheric regions and beyond in the Earth's atmosphere is under way by means of sounding rockets and Earth satellites.	(1) A similar detailed study is under way by the same means.
	(2) Work is under way to develop a routine rocket-sonde for synoptic studies of the lower portion of the upper atmosphere in association with meteorological soundings.	(2) The USSR has already achieved the development of a routine rocket-sonde for meteorological soundings into the lower portion of the upper atmosphere.
Ionosphere	Intensive rocket and satellite studies of the ionosphere in the F-region and beyond are under way.	Similar intensive studies are under way.
Magnetic Field	The US has used search coils, saturable-core magnetometers and proton precession magnetometers in its measurements of Earth's magnetic field. Preparations are being made to use a much more sensitive instrument, the alkali-vapour resonance magnetometer, for further studies of magnetic fields in space and to measure the magnetic field of the Moon.	The USSR has also used standard - type magnetometers and proton precession magnetometers for observations of the Earth's magnetic field. Workers have made a measurement to detect the lunar magnetic field, finding none to within the sensitivity of their instrument.
Cosmic Rays	Balloon, sounding-rocket, and satellite observations of the intensity, nature, and effect of cosmic rays are under way.	Similar observations under way.
Radiation Belt	Detailed study of the radiation belt by means of sounding rockets, satellites, and space probes, with occasional use of controlled experiments, is under way.	The USSR made intensive studies of the radiation belt in Sputnik 3, but now appears to be investigating the belt incidentally as part of their concentration on deeper space missions.
Aurora	Workers are tackling the problem of both visible and ultraviolet auroral radiations, the particles connected with the aurora, and the ultimate origin of the aurora.	Soviet workers are tackling the same problems.
Geodesy and Celestial Mechanics	The use of satellites for geodetic studies continues.	USSR shows skill in applications of celestial mechanics, as witnessed by their ability to launch Lunik 3 with accuracy and to predict its motions.
Meteors	Collection of data on meteors in space continues, using a wide variety of experimental equipments.	Intensive study of micrometeors in satellites and space probes; general problem apparently being attacked on US lines.
Astronomy	Active rocket astronomy in being. Orbiting telescopes, solar, and astrophysical observatories being worked on.	Unknown.
Lunar Exploration	Preparations to conduct intensive investigations of the Moon, but actual observation of the Moon from space vehicles yet to begin.	Significant steps in investigation and study of the Moon already achieved. It may be presumed that these vigorous efforts will continue.
Planetary Investigations	Minimal capability in this field at present, and on the present schedule planetary work is proceeding at a very slow pace.	Advanced capability in this area, and has declared its definite interest in planetary research.
Miscellaneous Experiments	US using upper-atmosphere regions for controlled chemical and Argus-type experiments. Also planning relativity and gravity experiments.	Unknown.
Biosciences and Man-In-Space	First-stage man-in-space programme in Project Mercury. Support work of a research type is being carried out in the Discoverer programme. Some experimental work is being carried out in sounding-rocket flights. A well-rounded, fully developed programme of research in both bio-technology and biosciences is yet to be worked out.	A highly active programme of research on animals under rocket flight and satellite conditions. It is not known how fully developed their bio-technical and fundamental biosciences programmes are. It is known from Sputnik 4 that the USSR does have a man-in-space programme.
Meteorology	US is developing rocket photographic techniques for meteorological purposes, and a meteorological sonde for synoptic soundings. The US is conducting fundamental satellite experiments associated with meteorology, and has taken the initial steps in the development of a meteorological satellite system.	USSR has already developed a working meteorological rocket-sonde, which they have already put to extensive use. It is not known what is being done in the matter of developing a satellite meteorological system.
Communications	In its rocket, satellite, and space-probe telemetry the US has shown good capability. Long-range communication systems have been demonstrated for deep space probes. Communication satellite systems are being worked on.	The Soviet rocket, satellite, and space-probe telemetry has been successful. In particular the communications and telemetry problems of Lunik 3 appear to have been worked out with a high degree of competence. It may be presumed that a communication satellite system is being developed.
Navigation	Work on a navigation satellite of high degree of refinement; initial launchings have been successful.	It is not known whether the USSR is devoting effort in this field.

SATELLITES AND PROBES: SCOREBOARD FOR THE YEAR

Satellite	Launch vehicle	Launch date	Est. lifetime or descent date	Shape	Payload (lb)	Incln. (deg)	Orbit (miles)	Period (min)	Experiments	Radio (Mc/s)	Remarks
Vanguard 3 (USA)	Vanguard SLV-7	Sep. 18, 1959	150 yr	20in dia sphere with 26in tapered tube	100 (50)	33.3	318-2,326	130	detect solar X-rays, measure Earth's magnetic field, micrometeorites, temps.	108 108.03	successful
Explorer 7 (USA)	Juno 2	Oct. 13, 1959	20 yr	double cone, 30in × 30in dia	92.3	50.3	345-675	101.3	measure Earth radiation balance, Lyman-alpha and soft X-radiation, heavy primary cosmic rays, micrometeorites, temps.	108 20	successful
Discoverer 7 (USA)	Thor-Agena	Nov. 7, 1959	Nov. 26	cone-cylinder, 19.2ft × 5ft dia	1,700 (300)	82	100-524	94.7	capsule ejection, re-entry and recovery	not disclosed	failed to eject, instability developed
Discoverer 8 (USA)	Thor-Agena	Nov. 20, 1959	Mar. 8, 1960	cone-cylinder 19.2ft × 5ft dia	1,700 (300)	81	115-1,043	103.7	capsule ejection, re-entry and recovery	not disclosed	capsule ejected but not recovered
Tiros 1 (USA)	Thor-Able	Apl. 1, 1960	50-100 yr (useful 78 days)	cylinder 19in × 42 in dia	270	48.3	430-467	99.2	test experimental TV techniques leading to meteorological information system	235 108 108.03	9,200 solar cells; video system relayed 22,952 cloud-cover pictures
Transit 1B (USA)	Thor-Able-Star	Apl. 13, 1960	16 months	sphere 36in dia	265	51	233-479	96	determine feasibility of global navigation system	54 162 216 324	chemical batteries charged by solar cells; system feasibility established
Discoverer 11 (USA)	Thor-Agena	Apl. 15, 1960	Apl. 26, 1960	cone-cylinder 19.2ft × 5ft dia	1,700 (300)	80.1	109-380	92.25	obtain data on propulsion, communications, orbital performance, stabilization, recovery techniques	not disclosed	capsule ejected but no recovery attempt; 10lb Transit instrument package included
Sputnik 4 (USSR)	not disclosed	May 15, 1960	2 yr	not disclosed	10,008 (5,512 cabin, 3,250 instruments)	64.9	*(a)180-420 (b)189-228 (c)171-429	94.25 91.25 94.27	test life-support system for manned space-flight; return cabin from orbit by retro-rocket	19.995	orientation fault caused change into higher orbit, not re-entry, on firing retro-rocket; cabin separation effected * (a) Sputnik 4, (b) rocket, (c) cabin.
Midas 2 (USA)	Atlas-Agena	May 24, 1960	40 months	cone-cylinder 22ft × 5ft dia	5,000	33	292-322	94.3	test system for detecting missile launchings with infra-red sensors	not disclosed	data-link telemetry ceased to function after two days
Transit 2A (USA)	Thor-Able-Star	June 22, 1960	50 yr (1 yr transmitting)	sphere, 36in dia	223	66.7	389-665	101.7	demonstrate feasibility of global navigation system, increase accuracy of geodetic measurements, provide accurate time standards	54 324 162 216 108	two satellites from one launching rocket, both transmitting data
NRL satellite (Greb) (USA)				sphere, 20in dia	42	66.8	382-657	101.6			

THE QUICK-REFERENCE HISTORY contained in these two tables covers the main details of all successful artificial Earth satellites and space probes launched between August 22, 1959 and July 28, 1960, and forms a second instalment to the list published in *Flight* of August 28, 1959.

The "orbit" column lists the initial perigee and apogee, and the period quoted is the initial period of the satellite. The payload given is normally the total weight of the object concerned, with the weight of scientific equipment in parentheses where known.

Satellites and probes covered in the earlier list comprised: USSR: Sputniks 1, 2 and 3 and Lunik 1. USA: Explorers 1, 3, 4 and 6; Vanguards 1 and 2; Score; Discoverers 1, 2, 5 and 6 and Pioneers 1, 2, 3 and 4.

The following space vehicles were in orbit at the time of going to Press (July 28):

USA.—Explorer 1, Vanguard 1, Vanguard 2, Pioneer 4, Explorer 6, Vanguard 3, Explorer 7, Pioneer 5, Tiros 1, Transit 1B, Midas 2, Transit 2A and NRL satellite.

USSR.—Lunik 1 and Sputnik 4.

Of these, Vanguard 1, Explorer 7, Tiros 1, Transit 1B, Midas 2, Transit 2A and the NRL satellite were still transmitting data. Lunik 1, Pioneer 4 and Pioneer 5 are in solar orbit, and the remainder in Earth orbit.

Probe	Launch vehicle	Launch date	Lifetime	Shape	Payload (lb)	Distance or orbit	Experiments	Radio (Mc/s)	Remarks
Lunik 2 (USSR)	not disclosed	Sep. 12, 1959	approx. 35 hr	sphere	860	236,875 miles	temps., pressures, magnetic fields of Earth and Moon, meteoric particles in space, cosmic rays	183.6 39.986 19.993 20.003† 19.997†	hit surface of Moon on Sep. 13, 1959 † Transmitters in rocket.
Lunik 3 (USSR)	not disclosed	Oct. 4, 1959	six months	ellipsoid, 4.3ft × 3.9ft dia	959 (614)	Earth orbit 30,000-291,000 miles; period 15 days 11hr 40min	photograph lunar surface, process films, transmit images to Earth, transmit other data	39.986 183.6	transmitted photographs of far side of Moon taken approx. 40,000 miles from lunar surface
Pioneer 5 (USA)	Thor-Able 4	Mar. 11, 1960	100,000 yr (useful 106 days)	26in dia sphere with "paddle-wheel" vanes	94.8 (40)	solar orbit between Earth and Venus, 74.9m-92.3m miles from Sun; period 311.6 days	investigate interplanetary space, test long-range communications, study measurement of astronomical distances	378	communication at record range; gauged solar flare effects, particle energies and distribution, and magnetic field phenomena; ceased transmitting June 26, 1960 when 22.5m miles from Earth after 138.9 hours data transmission

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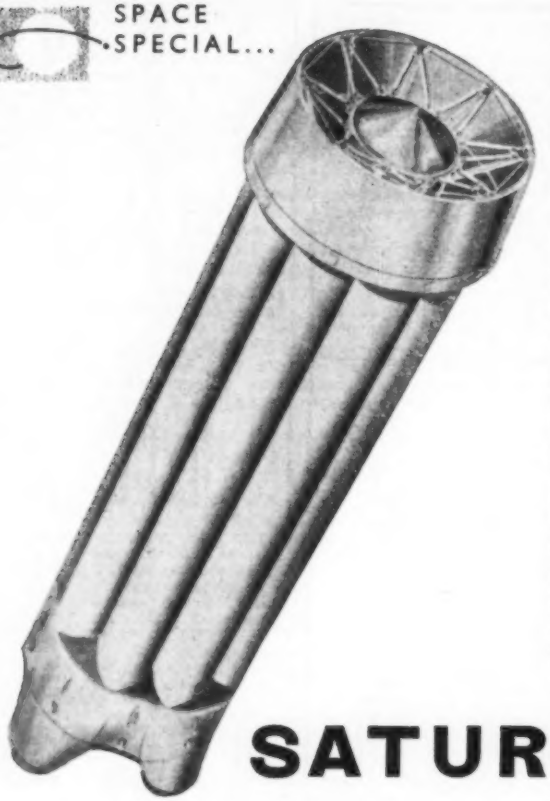

SATURN

A Space Booster to Fly Rings Round all Others

IT is appropriate in this issue to devote five pages to an outline of the Saturn programme, which will be the first non-military space booster aimed at placing really large payloads in orbit or deep space. After passing through various project phases it is now visualized in two forms: one will orbit payloads between 23,000 and 25,000lb, while the later version will be able to orbit 45,000lb, transport two men round the Moon and land them back on Earth, or soft-land instruments on Mars or Venus.

Although the Saturn programme has already absorbed $100m and a complete first stage has undergone extensive static firing, the original proposal to conduct such an exercise was made as recently as December 1957. In that month the US Army Ballistic Missile Agency put forward a formal recommendation for the early development of a booster with a thrust of 1,500,000lb. After preliminary discussions, the Advanced Research Projects Agency in August 1958 directed ABMA to initiate a development programme for such a booster, achieving the desired thrust by the use of a cluster of available rocket engines. This decision was of fundamental importance. Even at that time plans were afoot for the Rocketdyne F-1 with a single-unit thrust of 1,500,000lb, but this engine could not have been produced to anything like the time-scale of the Saturn project. Not only did the decision to use a cluster of existing engines enable the first full-scale captive firing to be timed for the end of 1959, but it also drastically reduced the cost of the project and increased the expected reliability. Moreover, the Saturn booster has been designed to fly successfully with at least one engine inoperative.

In the original ABMA study the specified powerplants were four 330,000lb Rocketdyne E-1s (*Flight*, November 13, 1959), but ARPA recommended that eight 150,000lb engines similar to those already in production for the Thor and Jupiter IRBMs would serve equally well and would reduce the powerplant development cost by about $50m. In November 1958 the Saturn booster became a firm programme as a high-performance first stage for a range of advanced multi-stage carrier vehicles for all kinds of space missions for the late 1960s. In the following month ABMA was asked to study possible upper stages, while authority was obtained to construct ground facilities including a large captive stand at Redstone Arsenal and a launch site at Cape Canaveral.

In May 1959 an *ad hoc* committee composed of members of ARPA and the National Aeronautics and Space Administration agreed that the upper stages should consist of a modified Titan first stage surmounted by the upper part of the Centaur. During the remainder of 1959 enough money was put into the first stage to maintain its development schedule, but little support could be given to the upper stages apart from their normal development under the Titan and Centaur programmes. However, a major change in the management of the project stemmed from the President's decision last November to transfer Saturn to NASA. In collaboration with the Department of Defense NASA prepared to assume immediate responsibility for technical management; and one of the first steps taken by the new administration was to review the multi-stage configuration and authorize new upper stages, since it was already clear that the payload ability of the original vehicle would be inadequate by the time it was available. Little could be done to change the first stage, but the successful demonstration by Pratt & Whitney at Palm Beach of the XLR115 liquid-hydrogen rocket (*Flight*, December 18, 1959), with specific impulse some 50 per cent greater than that of the standard oxygen/kerosine combination, opened the way to all-hydrogen upper stages of much higher performance.

Accordingly NASA authorized three new development steps. The first, designated C-1, is to be a three-stage vehicle (see table), the funding for which recommends one research and development launching in 1961, three in 1962, five in 1963 and one in the first quarter of 1964 followed by the first operational firing later in that year. C-2 is also described in the table, but is not yet subject to a definite schedule. The ultimate C-3 will be essentially the C-2 with the S-2 added between S-1 and S-3.

Had the Saturn been a NASA project from the outset it would probably have been adequately funded and might even have been an optimized design. Instead, not only has the miserable injection of money fallen far short of what the team at Huntsville—led by Dr Wernher von Braun—requested, but throughout the design of the S-1 booster ultimate performance has always been sacrificed in favour of achieving a conventional and conservative vehicle making minimum "state of the art" demands and likely to prove safe and reliable in operation. To this end, eight modified IRBM engines were used instead of a smaller number of later units, while the propellants were designed to be accommodated in a number of parallel tanks fabricated on existing missile tooling.

The contract for development of the engine was placed with Rocketdyne in September 1958. The design of this family began seven years ago for the booster package of the Navaho missile, and many hundreds of engines have since been produced at Neosho for the Atlas (booster), Jupiter and Thor. All these engines were described in our issue of March 20, 1959, and an MB-3 Thor engine was illustrated both in that issue and in a cutaway drawing of the missile in our issue of May 22, 1959. Rocketdyne had long appreciated that these engines were unduly complicated, and in developing the H-1 engine for Saturn introduced some welcome rationalization.

Although each of the eight engines has its own gas generator and turbopump, these components, together with the starting and control systems, are in the H-1 all mounted directly on the side of the combustion chamber. At the same time, the starting system has been drastically simplified. Exactly how the octet of engines operates is described later.

As already noted, the S-1 airframe is assembled from components which form a logical extension of existing practice. The basis of the booster consists of a tank system—not of the Atlas balloon type but with rigid walls—mounted between an upper adapter section and a lower tail section. The latter tie the tanks together and respectively provide links with the upper stages and with the engines and launcher. Centred on the axis of the booster is a liquid-oxygen tank of 105in diameter, fabricated largely on Jupiter tooling. Around it are clustered four liquid-oxygen tanks and four kerosine tanks, each with a diameter of 70in and as far as possible fabricated on Redstone tooling. It was not, however, possible to use existing tooling without alteration, and much new equipment was needed for the assembly of the complete S-1 (which has longer tanks than any missile).

In general the tanks are fabricated from 5456 aluminium alloy, contour milled to save weight. The sheets are then rolled and joined by automatic fusion welding, and each tank is completed by spot-welding the internal frames, which are perforated to form anti-slosh baffles, and adding the hemispherical end-bulkheads. The latter are each formed from a single chemically milled disc in a combination shear/spin/machining operation, and are joined by internal fillet welds. Dimensional accuracy of the tanks is achieved by routing the skin sheets to the exact length required and by parallel trimming of all tank sections.

An accompanying diagram portrays one end of the jig employed for overall assembly. At either end of the truss girders (1) is located an adjustable cradle support (2) on which is mounted a

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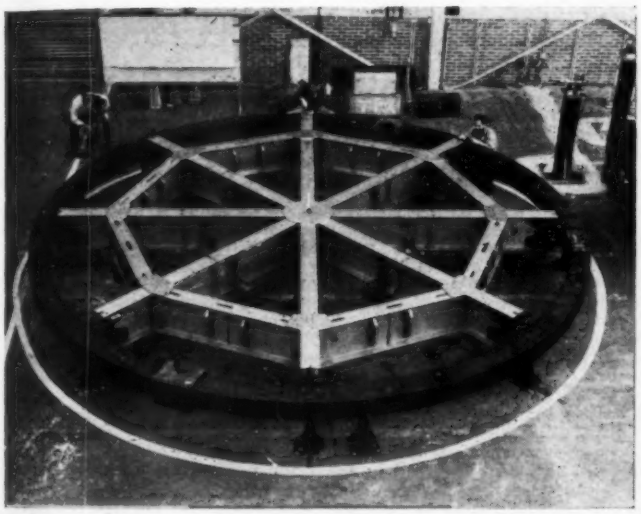
Major elements of the main assembly fixture are clarified by this sketch of one end. Trusses 1 link the roller supports 2 for the tool rings 3. After assembly, the walking gears 4 are put on for transport

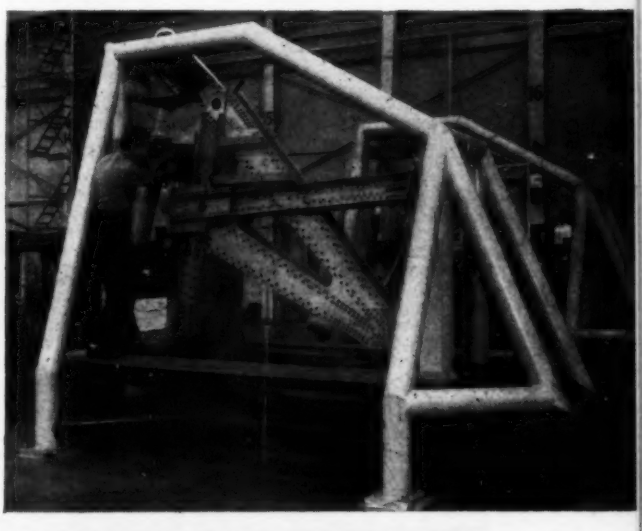
tool ring (3). These rings are segmented for ease of installation and bolted to the eight-armed spider of the prefabricated adapter section and to the outrigger support frames of the tail section. Once assembled the rings form an integral part of the complete S-1, essential for all handling and ground transportation. Around the assembly station are scaffold structures with hoists and elevators to serve workers at three levels. The complete installation includes optical alignment systems governed by remote push-button controls, and load-cells plus a further optical system for determination of weight and centre of gravity.

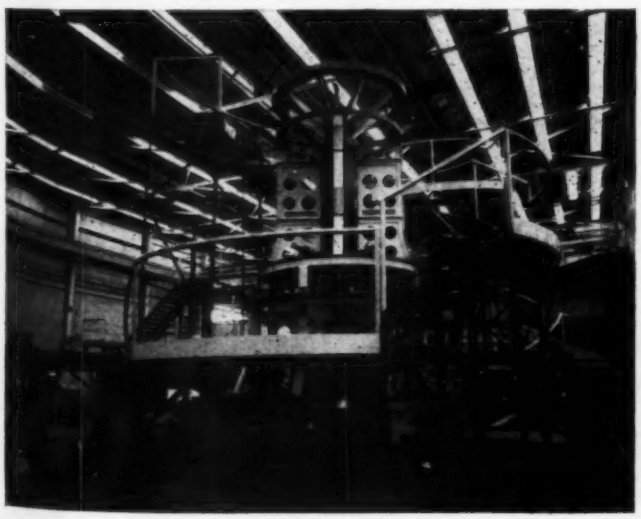
First part to be installed in the fixture is the prefabricated tail section, its tool ring being rested on the cradle rollers and held upright from above. To it is added the centre tank, and to the other end of this tank is then attached the adapter section and tool ring, 63ft away. The booster is completed by adding the four outer liquid-oxygen tanks from above, the complete assembly being rotated 90° at a time, and finally the four fuel tanks. All special equipment is then disconnected from the assembled booster, and the latter, complete with rings, cradles and trusses, is jacked up and put on front and rear tandem-wheel "walking gears" for transport.

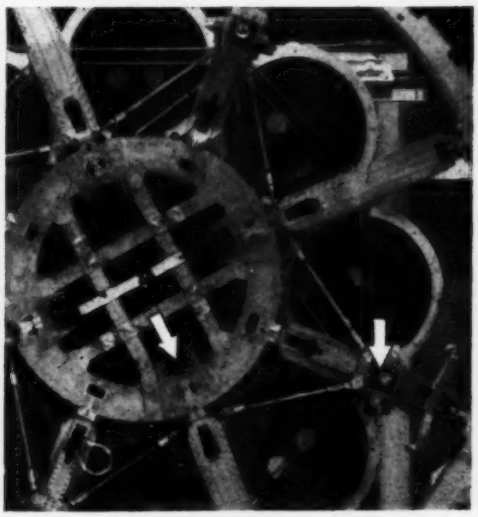
The first Saturn booster to be constructed was the SA-T static-test vehicle. It was built in building 4707 of the fabrication and assembly engineering laboratory at what was ABMA and is today the George C. Marshall Space Flight Center of NASA. The last

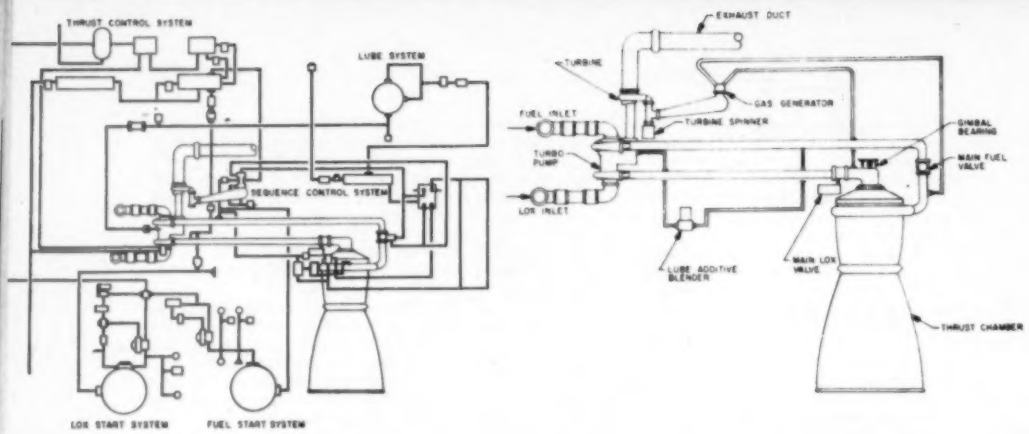
Those familiar with aircraft manufacture will find the illustrations below instructive. Upper left is the upper spider beam, part of the adapter section, being aligned on its locating fixture; members are 20in deep, in 7075 aluminium. Upper right can be seen manufacture of one of the eight outrigger support frames in its jig. At lower left is the vertical fixture in which the complete tail barrel is assembled. Lower right is an end view of the tail section; arrows show thrust pads for an inner engine and an outer engine











These diagrams from Rocketdyne emphasize the degree of simplification which the company achieved in the H-1 engine. The original IRBM powerplant (the Jupiter's S-3D is chosen) had a relatively complex starting system, which would have made the ignition and static firing of eight engines a protracted operation

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TECHNICAL DATA FOR C-1 AND C-2

Type of vehicle	Stage	Manufacturer	Stage type	No. of eng.	Thrust total (lb)	Type of engines	Engine manufacturer	Fuel	Oxy.	Development period
C-1	First	Marshall Spaceflight Center	S-1	8	1.5 m.	H-1	Rocketdyne	JP-1	O_2	1960-1964
C-1	Second	Douglas Aircraft	S-4	4	60-80,000	XLR115	Pratt & Whitney	H_2	O_2	1960-1963
C-1	Third	Convair	S-5	2	30-40,000	XLR115	Pratt & Whitney	H_2	O_2	1960-1962
C-2	First	Marshall Spaceflight Center	modified S-1	8	1.5 m.	H-1	Rocketdyne	JP-1	O_2	1963-1967
C-2	Second	?	S-2	4	800,000	?	Rocketdyne	H_2	O_2	1960-1964
C-2	Third	Douglas Aircraft	S-4	4	60-80,000	XLR115	Pratt & Whitney	H_2	O_2	1960-1963
C-2	Fourth	Convair	S-5	2	30-40,000	XLR115	Pratt & Whitney	H_2	O_2	1960-1962

Jupiter IRBM was completed in 4707 on July 27, 1959. As soon as the missile was out of the door the shops were retooled for the giant Saturn, and SA-T was complete and on public view last February 1. With walking gears attached and minus engines it was towed out of the shop in May, and installed on the completely rebuilt 177ft static-test tower at the establishment. There the eight H-1 engines were mated to the installed booster. First two engines were tested, then four, then six and finally the full cluster was ignited, with a delay of some days between each test. The first series of eight tests was completed at the beginning of July, by which time all eight engines had operated at the 1,300,000lb level for periods of up to 125sec continuously. A number of modifications have been made to the engines, and the complete booster has been built up to the flight configuration by adding the heat shrouds above the powerplant and the surrounding skirt section. Testing in this configuration is due to start in a few days.

"Production" boosters will be designated SA-1 *et seq.* Work already completed for these vehicles includes: tunnel programmes to investigate base heating; extensive running with a model powered by eight liquid-propellant 500lb engines to investigate airflow, heating and noise; establishment of the measuring programme and development of a telemetering system of exceptional capacity; production of all tooling items, the airborne electrical system and all parts of the control system; procurement of miscellaneous components for the reliability test programme; design of an enormous propellant-loading system of great accuracy; and the development of a complete system for ground transportation and post-flight recovery. Other work completed includes much of the structure of the great blockhouse and launch complex at the Cape, design work on the complete C-1 configuration and detail design of the dummy second stage required for the SA-1 launching next year.

When SA-1 has completed its tests at Marshall it will have to be transported to the Cape. All previous ballistic vehicles have had a diameter of 10ft or less, and have accordingly been transportable by road, rail or air. Any appreciable increase in diameter rules out air transportation, and once the girth exceeds 13ft any form of transport becomes difficult in the extreme. The S-1 stage has a diameter of 21ft 4in and length of 80ft, and cannot readily travel by either rail or highway. Disassembled it can be airlifted in 11 C-124s (nine carrying the tanks and two the engines and components) at a transporter cost of $200,000 and shipping cost put at $110,000. This procedure would entail assembly at the Cape, together with further static firing, realignment, pressure checks and system analysis. The cost of facilities and equipment to support dismantled transport preclude its further consideration.

The solution adopted is to ship each booster by water. Marshall is bordered by the Tennessee River, a navigable route connecting with the Ohio and Mississippi (1,470 miles) followed by the Gulf of Mexico and Atlantic (740 miles). Modifications are being made to eight miles of road at Marshall and about 1½ miles at Cape Canaveral, and work is in hand on the enclosed cargo barges which will be used for the water-borne journey. Transit time is estimated at 13 to 21 days.

Arrived at the Cape, the S-1 stage will be off-loaded at the foot of its 245ft service structure, by which it will be hoisted on to its launcher. Operational configurations will then be provided with their upper stages (SA-1 will have only a dummy second stage), which will be served from a three-station umbilical mast. Due to be completed early next year, the blockhouse is one of the largest yet designed, and in view of the fact that all the test and development flying is scheduled to be accomplished with but ten vehicles, each flight will involve the continuous monitoring of more than 600 channels.

In the original IRBM engine the starting system is complex, but all eight of Saturn's H-1 engines are started by a single electrical signal. This signal is first passed to one pair of opposite engines; it fires a solid-fuel cartridge on each engine to provide a flow of filtered hot gas to drive the adjacent turbopump. In spite of its size the turbopump rotor reaches full speed in a small fraction of a second. When design delivery pressure is reached the main delivery valves are opened, and the liquid oxygen and JP-1 are fed into the combustion chamber. On their way they rupture a small diaphragm which releases a pressurized charge of aluminium tri-ethyl, a hypergolic liquid, which is injected into the combustion chamber as the main propellant flow begins and causes spontaneous ignition. Thrust build-up is exceedingly rapid and the design sea-level rating of 188,000lb is reached in less than 0.5sec. The engines are started in pairs, since all eight firing together could impart a shock beyond the design loading cases. The next pair are fired after a delay of 0.4sec, and all eight reach full thrust a little over 1.5sec from the original firing signal.

Combustion pressure in all eight engines is monitored continuously. Should any engine fail to run up to full thrust an automatic "stop" sequence is triggered; this fires another solid-fuel cartridge on each engine which blows through the turbopump (which is by now running on the main propellants) in the wrong direction and brings it to rest. Should all eight engines reach 90 per cent of the design chamber pressure then the "launch" sequence is automatically engaged. This passes a signal

In the large drawing on the facing page our artist has graphically portrayed most of the main features of the present S-1 booster, slightly shortened axially in order to show the ends in greater detail. Inset at right is an elevation of a complete C-1 three-stage vehicle. This will have an overall height of 185ft, and diameters of 256in (S-1 first stage), 220in (S-4 second stage) and 120in (S-5 third stage); thrust at lift-off should be 1,504,000lb (8×188,000) and weight at lift-off 580 short tons (1,160,000lb)

SATURN

1 Centre (lox) tank, 105in diameter
2 Outer tank, 70in diameter
3 Lox tanks
4 JP-1 fuel tanks
5 Circumferential welds
6 Spot-welded inner frames
7 One-piece spun bulkhead
8 Outer-tank attachments
9 Centre tank to spider frame
10 Centre-tank base stiffeners
11 Thrust frame
12 Launcher hold-down lugs
13 Thrust-frame bracing
14 Lox filling point
15 Fuel filling point
16 Centre-tank filling and delivery junction
17 Lox delivery manifold
18 Fuel delivery manifold
19 Expansion and flexure bellows
20 Tank pressurizing bottles
21 Tank purging and venting
22 Lox pump (one per engine)
23 Lox delivery valve
24 Fuel pump (one per engine)
25 Turbopump lubricating oil additive reservoir
26 Turbine, started by gas from (27) and running on fuel-rich exhaust from (45) and driving pumps (22) and (24) through shaft and gearbox
27 Turbine spinner, containing solid charge
28 Turbine exhaust
29 Fuel circulation basket tubes
30 Turbine exhaust aspirators
31 Heat exchanger
32 Turbopump mountings
33 Gimbal-mounted outer engines
34 Fixed inner engines
35 Gimbal thrust pad
36 Thrust-chamber shrouds
37 Hydraulic gimballing actuators
38 Gold-plated bulkhead
39 Flexible seal
40 Lower spider frame
41 Recovery-system compartment
42 Adapter-section interconnecting structure
43 Mounting pads for second stage
44 Recovery-system retro-rockets
45 Turbopump gas generator

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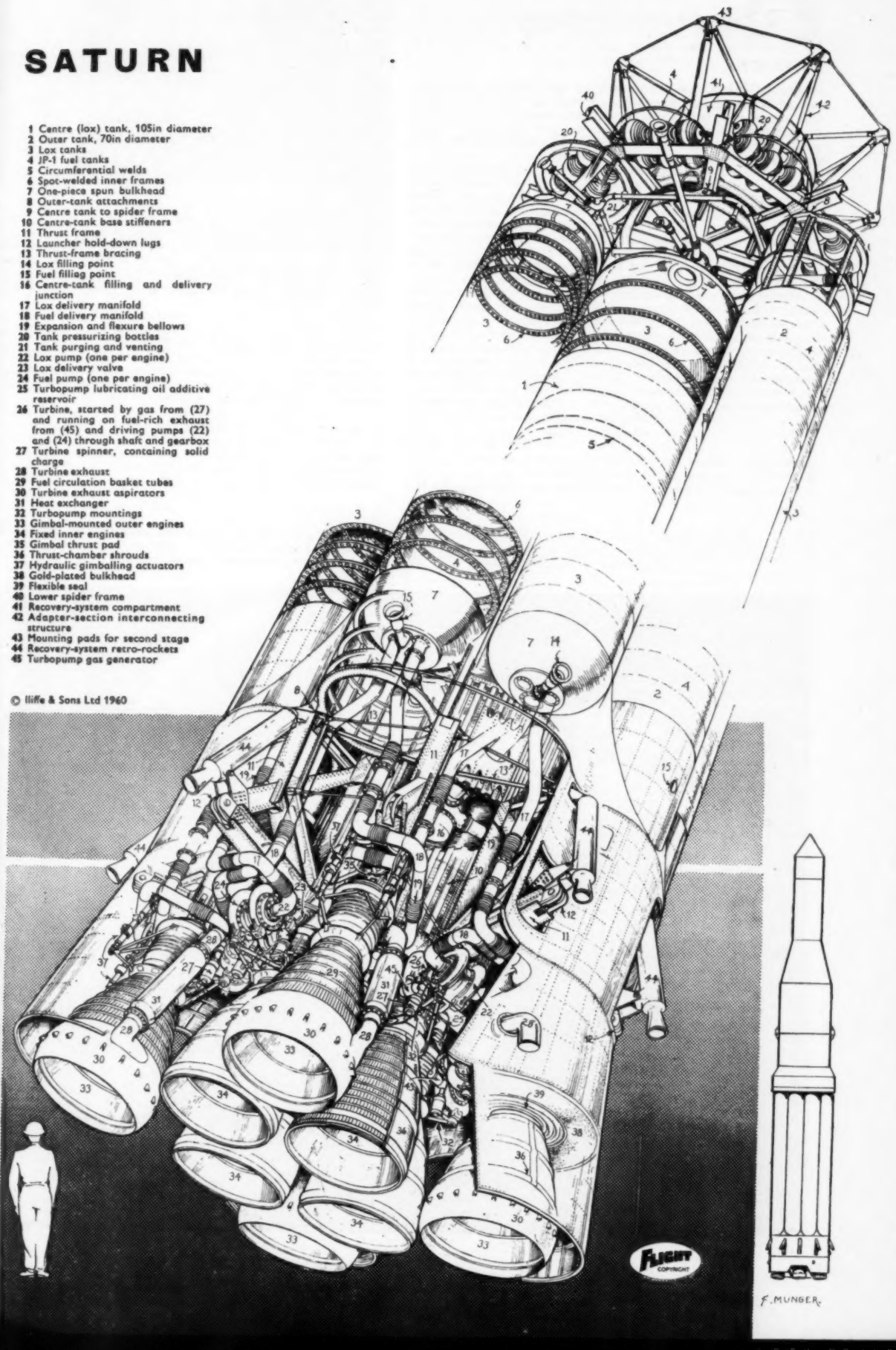

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to four of the hold-down clamps on the launcher which are rapidly driven radially outwards a distance of some 3ft. As they near the limit of their travel they trigger switches which actuate the other four clamps, which are of the flip-back variety. Rapid as this release arrangement is, all eight engines should be at 100 per cent thrust by the time it is completed.

After take-off the vehicle is controlled by gimballing the four outer engines through a wide angle by means of hydraulic jacks linked with the S-1's inertial guidance system. In the past ABMA have suffered greatly from mechanical failures in the flexible bellows which transmit the propellants at high pressure from the fixed turbopump to the gimballing chamber. In the S-1 the four outer engines will not suffer in this manner, since the turbopump moves with the chamber and the only bellows necessary are in the low-pressure pipes upstream of the turbopump.

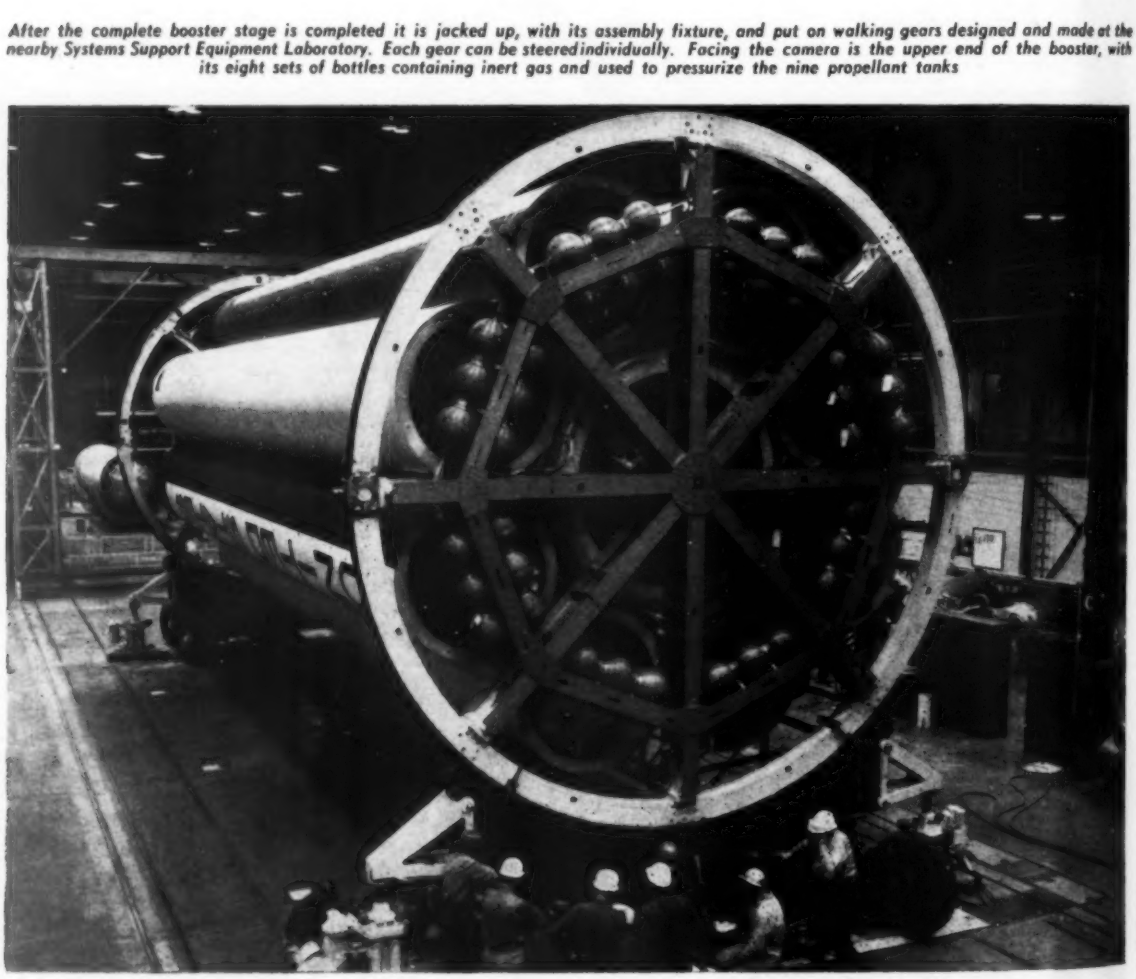
As the main drawing indicates, the gimballing outer engines differ from the fixed quartet in having heat exchangers in the large-diameter stack pipe down which the fuel-rich exhaust from the gas generator is dumped overboard. These four heat exchangers pass waste heat from the gas generators to the cold helium with which the main tanks are pressurized, and thus increase the overall thermal efficiency of the circuit. From the heat exchanger the exhaust is collected into an aspirator surrounding the main propulsive nozzle, so that the mixture is drawn out at high velocity, creating minimum back-pressure on the turbopump. The turbopump exhausts from the four fixed engines are ducted outboard and expelled in the high-velocity region immediately outside the skirt fairing, which is swept in between the outboard engines to shorten the pipe runs.

An indication of the difference in complexity between the H-1 and the IRBM engine from which it stemmed is provided by a diagram on page 192. Six weeks ago Rocketdyne conservatively rated the demonstrated reliability of the H-1 at 96.5 per cent, after 830 development firings and over 40,000sec of running time. Simple statistics show that the probability of all eight engines operating normally throughout any given mission is of the order of 75 per cent, and accordingly all Saturn configurations are designed to fly with only seven engines functioning. Moreover, after 60sec of flight all configurations can complete their mission with two engines out, increasing the overall mission reliability at this point to 99.2 per cent. Failure of one engine is automatically corrected by gimballing the outer engines and redistributing the fuel and oxygen supplies from the dead chamber.

Although the S-1 stage will be relatively inexpensive, the word "relatively" is of some importance, and much has been done to ensure that the greatest possible number of these boosters will be recovered and used again, perhaps several times. The basic design and stressing has been carried out to factors similar to those used in the design of transport aircraft. Accordingly, the Saturn airframe should be structurally capable of surviving a number of missions.

Contract for the recovery system was placed with Cook Electric, who are evolving an arrangement of parachutes and retro-rockets. The complete system has yet to be finalized, but initial deceleration from around M4.5 may be effected by a streamed balloon or mechanical brakes. At little more than sonic speed a ribbon-parachute will be deployed to bring the Mach number down to about 0.7, whereupon three 105ft canopies will be released to pull the speed right back to about 80ft/sec. Entry to the ocean will be softened by the eight retro-rockets, triggered by a water-sensitive switch hanging from a 100ft line, which will fire during the last second before impact. With empty tanks the complete stage should float in any normal sea, to be recovered, shipped back to Marshall and used again.

After the complete booster stage is completed it is jacked up, with its assembly fixture, and put on walking gears designed and made at the nearby Systems Support Equipment Laboratory. Each gear can be steered individually. Facing the camera is the upper end of the booster, with its eight sets of bottles containing inert gas and used to pressurize the nine propellant tanks



At this simple ceremony at Filton on June 27 Mr C. F. Uwins, deputy chairman of the Bristol Aeroplane Company, handed over Ghana's Britannia 309 to Mr E. Ayeh-Kumi, HE the Ambassador and minster plenipotentiary for Ghana

AIR COMMERCE

Comments on a Rough Draft

OPINIONS about this or that aspect of the new civil aviation licensing legislation have very often had to be qualified with the remark: "Oh well, let's wait to see what the Regulations say . . ."

A draft of these Regulations, which are necessary in order to implement the provisions of the Civil Aviation Licensing Act, has been laid before Parliament, and circulated by the Ministry to interested parties. They are asked to submit their comments by September 16. A note on the six classes of air service licence proposed appeared in last week's issue.

With one notable exception, which will be examined in a moment, the draft Regulations convey the impression of a Ministry leaning over backwards to give the new Air Transport Licensing Board as much authority as possible, and to abolish the secret-court mystique that has been so unhealthy a feature of the Air Transport Advisory Council system in the past. For example:—

(1) All hearings by the Board will be in public—"unless the Board shall otherwise decide in relation to the whole or part of a particular case" [R.12(3)]. This is the most enlightened regulation of the lot, and it is to be hoped that the conditional qualification will be sparingly invoked.

(2) All applications for new services will be available for inspection by any person [R.4(8)].

(3) The Board's reasons for its decisions will be published [R.10 (11) and (12)]. This is important because it means that the reasons for *negative* decisions will be always known—with the one exception which is examined in a moment.

(4) Appeals against the Board's decision's will be held in public by an independent commissioner, "unless he shall otherwise decide"—a qualification which again one hopes will be sparingly invoked [R.14(18)]. It is ruled also that if the Minister rejects the appeal-commissioner's recommendation, he "shall give his reasons" for so doing [R.14(15)]. The regulations should make it clear that these reasons will be published.

* * *

But the main weakness is to be found in Regulation 10(13): "*If the Board are obliged by subsection (3) of section 2 of the Act to refuse an application, an indication to that effect shall be sufficient reason for their decision.*"

The reference here is to that part of the Act which reads as follows: "If the application would in [the Minister's] opinion involve the negotiation with the government of some other country or territory of rights which it would be inexpedient for the time being to seek, the Board shall forthwith refuse that application."

There has always been concern that this part of the Act bids fair to undermine the authority and independence of the Board. We quote from *Flight* of February 26, page 283:—

"There are immense opportunities for Ministerial intervention here. There will seldom be any corporation or independent application (other than those for domestic or cabotage routes) which will not have to be interpreted in the context of Britain's international traffic rights. Thus every application will, it seems, first be scrutinized in this light by the Minister; if it looks politically tricky the Board will be told to refuse it . . . Traffic rights are an integral part of air transport, and the regulatory authority should have explicit powers to initiate policy and to interpret agreements. As it is, such powers will remain in the Ministry."

As matters stand the Minister can direct the Board to veto, on vague and unsubstantiated grounds of diplomatic inexpediency, any application for an international service—and that will be that. Traffic rights will be a closed shop, the stewards of which will be the Ministry. No applicant will be able to argue his case for entry before the Board: the Minister alone will be the arbiter of what is "inexpedient." We foresee here a source of great frustration for the operators—and for the Board.

Other Weak Points

There are other weaknesses: (1) The regulations should provide for the Board to call for and disseminate facts and figures about Britain's air transport industry, so that everyone, not least the industry itself, has a full picture (which it does not have now) of how British civil aviation is getting on. (2) The regulations should require that, if anyone—including the Minister—makes any "representation" to the Board under section 4(1) of the Act, then that representation should be published. Otherwise this bit of the Act may become a vehicle for a lot of quiet Ministerial intervention. (3) Transcripts of proceedings should always be available to any person, and not only in the event of an appeal [R.19(15)].

Finally, the draft Regulations diminish somewhat our fears* that "it will be disappointing if the new Licensing Board is frustrated by operators who feel that they only have to wave a secret pool agreement at the Board to ensure that their operations will be protected." As has been previously emphasized, any pool practitioner can object to an application under section 2(2)(g) of the Act. But Regulation 9 gives the Board the power to call upon the objector to "provide all such information and documents" as may be relevant. This is most important, because it is essential for the Board to have access to pool agreements. This would be an even better Regulation if it required that such information should be made public. Pools may be good things—but they must be seen to be good things. If there is a case for them then let it be discussed in the open.

But none of the 20 proposed Regulations actually undermines the Board's authority, such as it is. They appear to be the work of a Ministry which—while reserving unto itself powers over the Board that, in our view, are too great—has nevertheless sponsored legislation which is a big improvement on that which went before.

J. M. R.

*"*Pooling and the Public*," "*Flight*," *June 24, page 855.*

Helicopter services to Moscow's Sheremetyevo Airport take about ten minutes by Mi-4P from the Moscow heliport. There are 20 flights a day

AIR COMMERCE . . .

SIX SOLOMONS

"NOT less than six nor more than ten" is the number of members who, according to the Civil Aviation (Licensing) Act, shall be appointed to the new Air Transport Licensing Board. Lord Terrington's appointment as chairman has already been announced: here are the men—the minimum six—whom the Minister has chosen (leading article: page 169):—

Professor R. G. D. Allen, CBE. Age 54. Has been Professor of Statistics at the University of London since 1944. From 1928 he was an assistant lecturer (and later lecturer) in statistics at London School of Economics. From 1939 to 1944 he was a reader in economic statistics at the University of London and from 1939 to 1941 was a statistician in the Treasury. He was then appointed Director of Records and Statistics, British Supply Council, Washington, and subsequently British Director of Research and Statistics, Combined Production and Resources Board, Washington. From 1947 he was Statistical Officer to the Treasury and later Consultant, UN Statistical Office.

Mr C. Bagnall, CBE. Age 51. Managing director of British Nylon Spinners Ltd since 1945. From 1940 to 1942 he was Technical Adviser on Organization, War Office; from 1946 to 1949 chairman, Wales Business Training Committee; and from 1949 to 1952 a member of the council of the British Institute of Management. Mr Bagnall was a director of Oxford Business summer school in 1954 and a co-opted member of the Oxford University Appointments Board; chairman of the South West Regional Council of the Federation of British Industries in 1956-57; governor of Ashridge College in 1958; and chairman of the Regular Forces Resettlement Committee for Wales.

Mr E. Baldry, OBE. Age 65. Is a Fellow of the Institute of Chartered Accountants and is a senior partner in Allen, Baldry, Holman and Best, chartered accountants. Becoming a member of the Society of Incorporated Accountants in 1919, he has been in public practice for the past 33 years, and was elected a member of the Society's council in 1949 and has served on many of its committees. Mr Baldry represented the Society on the council of the London Chamber of Commerce from 1945 to 1957. He was elected vice-president of the Society in 1956 and elected to the council of the Institute of Chartered Accountants in 1957.

Sir Friston How, CB. Age 62. Joined the Civil Service in 1920 after serving in the forces in the 1914-1918 war. He was first appointed to the Exchequer and Auditing Department and later he became an inspector of taxes. From 1937 he served in the Civil Aviation Branch of the Air Ministry. During the Second World War he was with the Ministry of Aircraft Production. After the war Sir Friston served with the Ministry of Supply, where he held the rank of under-secretary. From 1954 until his retirement in 1959 he was the secretary of the Atomic Energy Office.

Mr W. P. James, OBE. Age 67. Joined the Civil Service in 1919 after serving in the forces in the 1914-1918 war. He was first appointed to the Ministry of Pensions. From 1934 he served in the Ministry of Transport, in the Road Transport and Shipping divisions, and since 1952 has been chairman, West Midland Traffic Area.

Mr A. H. Wilson, CB, CBE. Age 65. Was until recently Adviser on Commercial Air Transport at the Ministry of Aviation and is now an assessor with the Air Transport Advisory Council. He joined the Civil Service in 1930, being first appointed to the Board of Trade, later serving in the General Post Office and the Air Ministry. In 1943 he was appointed Assistant Secretary in the Civil Aviation department which, in 1945, became the Ministry of Civil Aviation. He was promoted Under Secretary in 1946 and Deputy Secretary in 1956. Upon his retirement in 1958 he was re-appointed as adviser on commercial air transport.

MERCURY AIRLINES

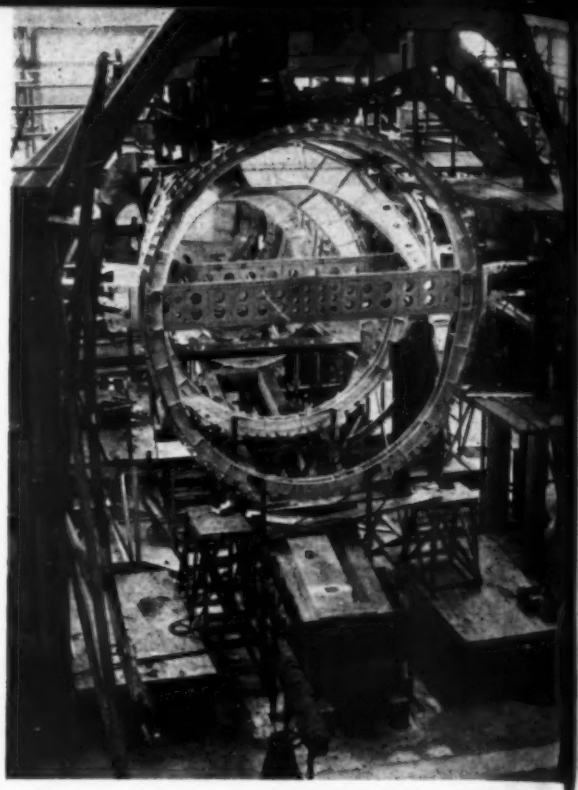
REGISTERED in Jersey last week was a new independent operator, Mercury Airlines Ltd. The purpose of the company, which has a nominal authorized capital of £1,000, is said to be the provision of air transport and the carriage of passengers and freight to and from the Channel Islands. Founder members are: the Hon Peter Gough, 11th Baron Calthorpe; the Hon Dame Anne Sarah Gough; Ralph Vibert, Vivian Vibert, John Langin, Denis Pipon, Miss Anne Harper and Mrs Lydie Pallot.

CAA's £70,000 PROFIT

A PROFIT after payment of interest amounting to about £70,000 was made by Central African Airways in 1959-1960, interest payments amounting to more than £150,000. This result, announced by the chairman, Mr A. E. P. Robinson, compares with a loss last year of £169,000. With some satisfaction CAA says that it will not require any of the £160,000 subsidy voted by Parliament in July 1959. The airline adds:

"In short, this achievement means that Central African Airways can fairly be said to have recovered from the serious financial crisis in which it found itself in 1957 and which had caused a lot of adverse Press and Parliamentary comment in that year, though the corporation will not be satisfied until an adequate contingency reserve can be established out of profits as a cushion against trading fluctuations from year to year.

"The national airline, in fact, has taken on a new look . . . after three years of hard effort involving the complete re-organization of the corporation's affairs."



This photograph of the first VC10 fuselage under construction at Weybridge shows the way the torsion box from which the engines are suspended will pick up on two transverse fuselage beams

THE VOICE OF THE PASSENGER

"YOU must feel, as we do, that it is about time the airline passenger had a strong active organization working for him. As airlines have grown, so the passenger's problems are frequently overlooked. Burdensome baggage restrictions, overbooked flights, time-wasting ticketing, inconvenient scheduling—these are some of the problems facing airline passengers every single day. . . .

"Most important of all is the matter of your safety and security. . . . Now, at government hearings and investigations about airline matters, the passengers' views will be presented too—at long last."

The above is an extract from a letter being circulated by the Airways Club, a new American organization which is aimed at caring for the interests of the passenger.

Every section of air transport has its club; at a rough *Flight* count there are 15 major organizations embracing all those in air transport except those around whom the whole industry revolves—the passengers. Over three years ago a club known as the International Society of Air Travellers was launched in London, with Lord Brabazon as chairman, whose declared object was "to care for the legitimate interests, safety, comfort and convenience of air travellers and air transport users" (*Flight*, April 5, 1957). Annual subscription was 3gns. Nothing has since been heard of it; but air travellers who feel that their interests are not sufficiently being cared for are now invited to join the Airways Club.

The address is 240 Madison Avenue, New York 16. The president is Howard G. Law, Jr, formerly of the CAA and later the FAA, a former airline pilot, and a serving commander in the US Naval Air Reserve. Executive vice-president is William R. Beattie, for 25 years in the US air transport business (including chairmanship of the IATA agency committee). Vice-president and treasurer is David C. Quinn, until recently Assistant Attorney General of the State of New York and a pilot with 20 years' experience who also serves in the US Naval Air Reserve.

The primary benefit of membership is an insurance plan which offers coverage from $15,000 to $150 000 for travel on "every certificated scheduled airline flight, domestic or foreign, regular or charter, anywhere in the world." Annual premiums range from $10 to $65, and the coverage increases automatically at the rate of $1.000 per year for the first five years without increase in premium. Other "exclusive privileges" of membership are: "(1) Effective presentation of your viewpoint as an airline passenger; (2) A passenger service department to follow through your complaints; (3) A safety department to give you a voice in decisions vitally affecting your security; (4) A free monthly publication, 'The Airways Traveller'; (5) Lapel badge and membership card."

Insurance coverage is underwritten by the Guardian Life Insurance Company of America.

BOAC Loses Less

BOAC lost £833,795 in 1959-60, a small profit on the corporation's own services and a dramatic improvement in the affairs of their associate Middle East Airlines being outweighed by substantial losses of two other associates—British West Indian Airways and Kuwait Airways. These are the broad facts shown by BOAC's 1959-60 report and accounts published last week.

The improvement in BOAC's own figures is entirely the result of lower costs, these having fallen from the 40d per c.t.m. typical of recent years down to 34d in 1959-60, the latest figure being a reduction of 6½ per cent on the 1958-59 figure.

This reduction, most of which was due to lower engineering costs, was slightly offset by a small fall in load factor (57.0 to 56.7 per cent) and by a 3½ per cent fall in the average revenue rate. The combined effect of these trends—on a level of business that was expanded by 25 per cent over the year—was to bolster the profit on the corporation's own services from about £0.8m in 1958-59 to £4.3m before paying interest on capital. After allowance has been made for interest, the 1958-59 loss of £2m is seen to have been converted in 1959-60 into a £277,813 profit.

BOAC's 14 associated companies also showed improvement, the previous year's deficit of £3.1m (£2.5m losses plus £0.6m interest) being reduced to £1.1m (£0.6m losses plus £0.5m interest). The credit for this improvement must go to Middle East Airlines; whereas BOAC showed a loss of £1¼m on its investment in MEA in 1958-59, last year the corporation showed a profit of £17,000 from this company. Results for the other associates tended to be indifferent, with the two heaviest losers—BWIA and Kuwait Airways—showing even worse losses than before (£618,000 and £240,000 respectively).

Returning to the records for BOAC's own services, a number of factors other than lower engineering costs have contributed to the more cheering financial results. The first of these was a 6 per cent improvement in average aircraft utilization, now seen to be up to 2,623 hours p.a. Next there was an 11 per cent increase in average stage length to bring the average up to over 1,300 miles. (Nevertheless, for a long-haul airline experiencing an average passenger-haul of some 3,125 miles, this average stage length still appears uneconomically low.) Then there was a 22 per cent improvement in aircraft productivity, the use of faster and larger equipment resulting in average c.t.m.s. per hour rising from 2,400 to 2,900. This explains how the corporation's output rose by 25 per cent from 377m to 471m c.t.m. while flying hours rose only fractionally from 150,000 to 151,000.

The additional capacity was almost entirely deployed on the corporation's western routes with the result that, for the first time in BOAC's history, the scheduled capacity made available across the Atlantic caught up with the capacity offered on the Eastern and African routes (216 million c.t.m.s. in each case). The magnitude of this swing is shown by comparing 1959-60 capacity on each of these areas with 1958-59; whereas western routes expanded by 46 per cent, eastern plus African routes expanded by only 6 per cent. Because of lower load factors across the Atlantic, the Eastern/African routes still show the most traffic (132m l.t.m. as against 113 l.t.m.).

Another startling development in the disposition of BOAC's capacity was a remarkable 40 per cent rise in charter services. This business, worth more than £1¼m, could well mean that BOAC may soon do more charter work than any of Britain's so-called charter companies. With the threat of obsolescence already hanging over the Britannia and DC-7C fleets, this trend is perhaps the shadow of things to come (see below).

BOAC's MONEY (round figures) 1959/60

	BOAC services	Associate services	Total
Before interest	£4·3m profit	£0·6m loss	£3·7m profit
Interest	£4·0m	£0·5m	£4·5m
After interest	£0·3m profit	£1·1m loss	£0·8m loss

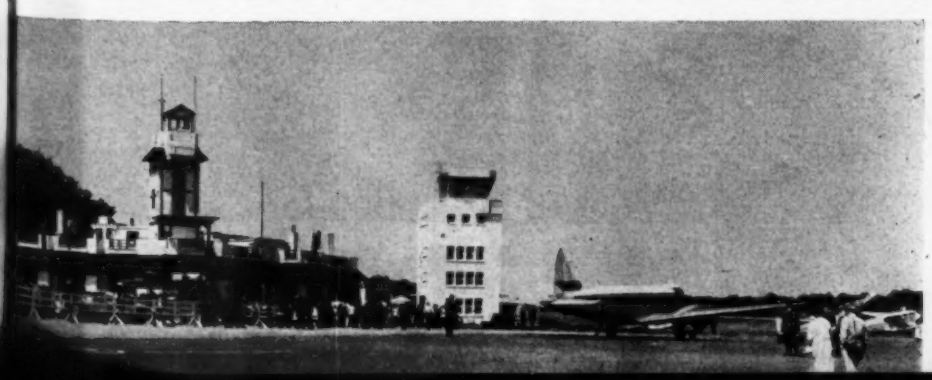
The News Conference. Some of the points that came up in answer to questions at a news conference—Sir Gerard d'Erlanger's last appearance as chairman of BOAC before handing over to Sir Matthew Slattery—were as follows: (1) The cost per seat-mile of supersonic air transports will in BOAC's estimate be higher than subsonic jets by amounts ranging from 15 per cent to 50 per cent per seat-mile. This covered the range of Mach numbers from about M.2 to about M.3. Sir Gerard d'Erlanger said that surcharges might be necessary. (2) If any independent applied to operate transatlantic services that appeared to damage BOAC's interests, these would "certainly" be opposed. (3) No information could be given about BOAC's pool agreements with the independents. (4) The possibility of converting BOAC's DC-7Cs or Britannias to all-freight use was being considered. (5) Sir Gerard would like to see the corporation relieved of interest charges, 'though to be relieved of them entirely would be unreasonable." But it was as unreasonable to pay interest on all capital whether profits were made or not, as was the case at present. He was pointing out the problem, and could go no further. (6) The DC-7C fleet might continue operating charter work for another two or three years—longer if BOAC were allowed to do so by the Government. [In the report Sir Gerard d'Erlanger referred to the big losses that might be sustained on the disposal of DC-7Cs and Britannias unless a profitable use for these aircraft could be found.] (7) Mr Sandys had said that he was going to help the aircraft industry more, but he had not committed himself to support for BOAC's aircraft development costs. (8) Next year BOAC, excluding the associates, were budgeting to break even after interest charges; so far as the associates were concerned, there would be a slight improvement on last year's results.

[*A fuller review of BOAC's 1959-60 Report and Accounts will appear in a subsequent issue.*]

CAPITAL TO MERGE WITH UNITED

ON July 28 it was announced by Mr W. A. Patterson, president of United Air Lines, and Thomas D. Neelands, recently appointed chairman of Capital, that Capital Airlines would be merged into United, subject to the approval of the CAB and the airlines' shareholders. It is presumably no coincidence that Mr Neelands, a former Capital director, is a Wall Street consultant and merger specialist. Support for the merger is given by Vickers: Sir Charles Dunphie, chairman of Vickers-Armstrongs, said that the holders of Capital's secured promissory notes "had agreed to co-operate fully in bringing the merger about." The terms proposed by the managements of United and Capital are that 15 Capital Viscounts would be returned to Vickers-Armstrongs; holders of notes under the chattel mortgage would receive in compensation $15.9m 5½ per cent United cumulative preference stock; 60,000 shares of United common stock; and 7½ year warrants to purchase 200,000 United common shares at $45 per share. Capital's shareholders will receive one share of United common stock and a five year warrant to purchase 1½ United shares at $40 a share against seven shares of Capital common. An offer is to be made to holders of Capital 4½ per cent debentures of 20 shares of United common for each $1,000 principal amount of debenture, provided that 85 per cent of the $12m debentures are deposited for exchange.

The combination of United and Capital routes would give the merged airline a network of routes from coast to coast across the United States, to Hawaii, and from New York over the country east of the Mississippi. Route mileage would total over 20,000 and employees (United 23,310, Capital 7,840) over 30,000. The combined fleet would include 259 four-engined transports apart from the 14 remaining DC-8s and 21 Boeing 720s which United have on order. The airline are also buying 20 Caravelle 6s. Capital's order for seven Convair 880s has been cancelled.



A new control tower has recently been constructed at Deauville Airport, near the present terminal building. It will enter service as soon as control equipment is installed

AIR COMMERCE . . .

YEADON ASKS FOR AID

SHOULD the 3½ million people in the conurbation of the cities of Leeds and Bradford have available a network of connecting services to other centres of population? If so, whose responsibility is it to provide them? That of the Government through the national airline BEA, or—by encouraging the activities of the independents—the Joint Aerodrome Committee of the two cities?

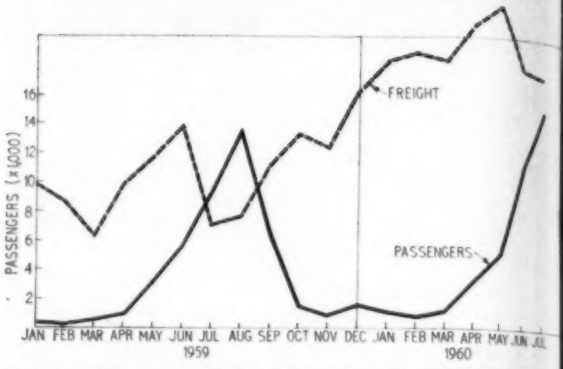
These are the big questions facing the Leeds/Bradford Airport at Yeadon in its year of most ebullient growth. Derequisitioned at the beginning of 1959 and taken over again by its pre-war owners the Leeds/Bradford Joint Aerodrome Committee, the airport is now up to date, efficient and quite well equipped. But for its future to be assured it is too small; the runways are too short for BEA or Aer Lingus' Viscounts; accommodation for passengers is temporary and now inadequate; and apron space for parking the number of aircraft which are anticipated next year is very limited. Hangarage, on the other hand, is available in plenty but much of it is too near the runway to meet current ICAO standards and some of it must soon be dismantled.

Yet Yeadon is Britain's fastest growing airport; and although it may be argued that this is not surprising when the base line of last year's operations was so small, by 1965 the present rate of growth should bring to Yeadon 150,000-200,000 passengers a year. Because it is Yorkshire's only airport, say its supporters, this expansion of traffic is progress that cannot easily be halted. Yet to expand the airport as it is now, to build a new runway and erect a new terminal building would cost a great deal of money. This is the crux of present arguments about the airport's future. Will the Ministry of Aviation provide a "substantial part" of the sum of about £1½ million needed to expand Yeadon to a size where it will be capable of taking Vanguard-sized aircraft?

The Joint Committee (the responsibility for the airport is shared on a 50-50 basis between Leeds and Bradford) will not admit the possibility that support will not be forthcoming. They regard it as the nation's responsibility to see that north-east England is either provided with better services or with the facilities for enabling these services to be operated by independent companies who are prepared to take them on.

When the airport resumed operations under its pre-war management again BKS were the only operators. The city councils took the decision then to make Yeadon into a first-class airport for intra-European traffic and at that early stage high- and low-intensity lighting, runway markings, airfield radar, CRDF and new fire vehicles and buildings were installed to attract new operators. Three other scheduled-service airlines (Silver City, North-South Airlines and Aer Lingus) now operate besides BKS and passenger and freight traffic are now about double that carried last year. A twice-daily BKS service to London Airport is envisaged, and North-South may operate between Yeadon and Leavesden; next year 2,000-3,000 passengers a month may be travelling to London.

The airport's most urgent immediate need is for a new terminal building and parking apron to handle the additional traffic which should be attracted by the Avro 748s which BKS will operate through Leeds/Bradford from next spring. While the present runways (10/28, 3,950ft, and 01/19, 3,500ft) are adequate for turbine aircraft of this or Friendship size the airport authorities suggest that by 1963 "the need for bigger aircraft will have become an economic necessity" and the numbers of passengers and the amount of freight which will be handled would completely justify construction of a 7,500ft runway and the diversion or submerging of the Leeds - Harrogate road. This is unfortunately a prerequisite to expansion in the only practical direction, NW/SE. But a new runway would not be built without Government assistance, because although the operational cost of the airport can be met from income, such heavy capital expenditure would plunge the airport's finances deeply into the red. Last year, when capital had to be found to install new aids and to modernize the airport there was a deficit of nearly £50,000 on an income of about £25,000.



Eighteen months of operations at Yeadon Airport. While traffic has expanded rapidly, a big seasonal problem has grown up as well

Yeadon's argument for Government support for its expansion is that there are ¼ million people in Bradford, ½ million in Leeds and in the other West Riding towns of Harrogate, Keighley, Huddersfield, York, Goole, Hull and Sheffield a combined population of nearly 3½ million. It is an expanding and prosperous business community with a developing need for air services. The West Riding wants to develop an airport of its own; Manchester, 40 miles across the Pennines, is not accepted as a suitable alternative. Newcastle is too far to the north and the only other possible alternative, Derby, is much too far to the south. Now that suitable aids are installed it is claimed that Yeadon's weather record (low cloud rather than fog is the restriction) need no longer hamper operations. And although customs are officially available only "on request" the pressure of customs work is such that an officer is daily in attendance practically throughout daylight hours.

The airport committee believe that the Ministry are sympathetic to their plea for immediate assistance with a new apron and terminal building. A deputation (see *Flight*, February 26) which visited Mr Sandys recently was well received and a detailed plan of development was requested. Nevertheless, this is still a far cry from the full-scale development assistance for which the West Riding are asking and a more positive national policy for Britain's airports and internal services may have to be formulated before a decision is reached.

Perhaps the strongest argument for the expansion of services from Yeadon was put forward by the Leeds and Bradford Chambers of Commerce. A questionnaire dealing with the desirability of a London service which was recently circulated to selected local firms brought 100 affirmative replies by return of post. To each was appended the single question "When?" A. T. P.

These "Flight" photographs, taken last week, show Yeadon Airport as brought up to date by the Leeds/Bradford joint aerodrome committee. Although suitable for the Avro 748, the runways cannot be extended to take larger aircraft and some of the buildings in the photograph on the left are positioned too near to the runway. Plans for future development include a new permanent terminal building and a new 7,500ft runway running NW/SE—horizontally from left to right across the right hand picture

DANGEROUS DIVERSION

THE British United Airways Britannia which was forced to land at Ankara on July 18 was the subject of a question in the Commons last week. The aircraft, which was carrying 103 servicemen and their families and eleven crew, was requested to land at Ankara Airport by the Turkish air traffic control authorities. Previously it had been reported that it was intercepted and forced down by four jet fighters from the Eskisehir air base in Western Turkey after it had overflown a prohibited military zone. In a written reply, Mr R. Allan, Joint Parliamentary Under Secretary to the Foreign Office, said that the pilot had been briefly questioned and the aircraft was subsequently allowed to resume its flight. The reason for the deviation from the authorized route was being investigated. Earlier it was said that the pilot had reported that he had been unable to follow his assigned course because of bad weather.

MEA STEPS UP THE PACE

IN June this year MEA's seven Viscounts achieved a utilization of 9.55hr a day. Total hours flown by the Viscount fleet in the first half of the year is 13 per cent higher than it was in 1959. Passenger traffic was up too; in the first six months of 1960 the increase over last year was 14 per cent.

The airline is now actively preparing for its Comet 4Cs, the first of which should be delivered in December this year. An initial group of MEA captains and first officers should arrive in Britain for conversion training next Monday, August 8, as the spearhead of three courses which will be held later this year. The total number of pilots who will attend before an aircraft is delivered is 23, but others will follow in the new year. When the Comet 4Cs go into service they will operate return flights from Beirut to Vienna, Frankfurt and London three times a week; Beirut, Athens, Geneva and London three times a week; and Beirut, Rome and London once a week, so that MEA Comets will operate a daily service between London and Beirut. The remaining service westwards from Beirut is to Rome, Madrid and Lisbon on a service which will operate twice a week. Eastwards, Comets will operate to Dhahran, Karachi, Kuwait, Bahrein, Dohar, Jeddah, Aden, Baghdad and Tehran.

SPRINGBOKS LEAP THEIR TROUBLES

NEITHER Kano, Nigeria, nor Leopoldville in the Belgian Congo will be served by South African Airways Boeing 707s when they go into service on the London route on October 1 (see *Flight*, July 15, 1960). The airline does not have traffic rights at Kano but has previously used the airport to refuel its DC-7Bs. The 707s may now use Brazzaville for refuelling or may possibly —when the 4,000ft main runway extension at Johannesburg Jan Smuts Airport is finished—operate non-stop to Rome.

The decision not to use Kano is said to have been taken before the Addis Ababa conference at which refusal was threatened of ground facilities and airspace to South African Airways. Mr D. H. C. de Plessis, general manager of South Africa's railways administration, has said that SAA has already written off the west coast of Africa because of the paucity of traffic. In any case it seems that the decision to call at Brazzaville may also be temporary; when Jan Smuts extensions are complete the 707s will be able to fly between Johannesburg and Rome without any penalty in payload.

Four return flights a week to London have been scheduled, but these will not keep the three 707s fully utilized. Although frequencies may be stepped up in 1961 it has been queried whether the airline have plans for expansion in other directions—say to fly to Louanda in Angola (which has been used by SAA DC-7Bs during the present Congo troubles) and then across the hump of Africa to the Canaries or Spanish Africa. Mr du Plessis said recently that SAA now considered that the Boeings would break even with a 60 per cent payload in contrast to earlier estimates of 70 per cent. But SAA still does not expect to make money on the 707, initially at least.

BREVITIES

Boston and Providence have been added to Allegheny Airlines' "no reservation" commuter network.

Starways of Liverpool have applied for a UK internal service on the route Dundee and/or Glasgow, Liverpool and/or London with DC-3s or DC-4s.

July 29 was the first anniversary of Boeing 707 operations by Qantas. The seven aircraft have flown 16,300hr since July 1959, an average of 2,330hr per aircraft per year, or 6.45hr per aircraft per day.

The new runway at Coventry Airport is to be equipped with airfield lighting supplied by General Electric Co. The contract for high-intensity runway lights, high- and low-intensity approach lights, taxiway lights and control gear is worth about £10,000.

Having sprung its Boeing 707-420 surprise in the 59th market report, *Aircraft Exchange* this month offers three Short Solent Mk 3 flying-boats. They are offered as a lot with a substantial quantity of spare parts for $340,000.

Mr A. E. C. Derrett has been appointed BOAC sales manager in Brazil. He will shortly take up duties in Rio de Janeiro

Ansett-ANA, it is reported, have received the Australian Government's approval for the purchase of another Viscount and three Fokker Friendships.

Carvair is the name to be adopted by Channel Air Bridge for the Aviation Traders ATL-98 conversion of the Douglas DC-4. The name is compounded of the words "cars-via-air" and was suggested by two of 5,000 competitors who participated in the contest organized by the Air Bridge to name the new aircraft. The two winners are to be given free cross-Channel trips with their cars.

Jersey Airlines' interest in the Handley Page Herald or the Avro 748 is expressed in an application to the ATAC to operate scheduled services with these aircraft (following an initial period with Dakotas or Herons) between Coventry and Dublin. The frequency applied for is initially three return flights a week. Air Safaris are another operator with Heralds in mind. They have applied to operate them (to complement DC-6s after a period with Hermes) between Gatwick - Bournemouth - Biarritz and Faro.

Mr T. M. Noble, formerly general manager of Airline Air Spares, Southend, has been appointed a director.

The use of flight recorders in jets and turboprops of more than 12,500lb take-off weight is to be made mandatory by the FAA from November 1, but until May 1, 1961 is allowed for recorders to be fitted.

Aerolineas took delivery of their sixth Comet 4 at Hatfield on July 25. The first overseas operator to buy Comets, their order is now complete. Eight Comets were due to have been handed over in the three months ending on the last day of July this year.

East African Airways Comet services between London and Nairobi are now scheduled to start on September 17 and to Dar-es-Salaam on September 22. The twice-weekly Nairobi services will be routed via Rome, Khartoum and Entebbe, and the weekly service to Dar-es-Salaam via Rome, Khartoum and Nairobi.

The first DC-7F all-cargo transport went into American Airlines freight service last Monday. The aircraft are being used to operate American's first non-stop coast-to-coast all-cargo service. Final deliveries of the 15 DC-7Fs which the airline has on order should be by the end of the year. Passenger revenue miles in the first half of 1960 increased by 24 per cent over the same period of last year but profit was down by about a fifth.

Yeugeny Loginov, chief of Aeroflot, said recently that Soviet passenger and freight services have expanded to such an extent that as many passengers were carried last year as between 1951 and 1956. The Russian seven-year plan anticipates a sixfold increase during the years 1959-65. By the end of this period, he said, the Soviet Union will have considerably surpassed all 50 air companies of the United States taken together for the volume of air carriage."

After 13 accident-free years of airmail and passenger services on a network of routes based on the downtown Chicago, Midway and O'Hare Airports, a Chicago Helicopter Airways S-58 was involved in a fatal accident on July 28. The helicopter, which was carrying eleven passengers and a crew of two, crashed into a Chicago cemetery and caught fire. There were no survivors. The S-58 was one of eight operated by the airline.

On the right, behind the Sabena board, is the fuselage of the first Caravelle 6, the heavier (103,620lb) version with 12,500lb thrust Avon 531s. Soon to be added at Sud's Toulouse factory are the wings, which are built at Bougenais (Nantes) and the tail, built by Fiat at Turin. Sabena have four Caravelle 6s on order and the first will be be delivered "at the beginning of next year"

The Queen inspecting a line-up of RAF College aircraft during her visit to Cranwell on July 25 ("Flight," last week). With her is the OC Flying Wing, Wg Cdr C. F. Green; behind are the Duke of Edinburgh and the College Commandant, Air Cdre D. F. Spotswood

SERVICE AVIATION

Air Force, Naval and Army Flying News

Good Ideas Wanted

AT Henlow on Thursday last week the Chief of the Air Staff, Air Chief Marshal Sir Thomas Pike, stressed the importance for RAF officers of activities and interests beyond the horizons of Service life. "You must be prepared to think," he told the graduation parade of No 6 Entry Technical Cadets (Henlow) and No 8 Entry Technical Cadets (University) at the RAF Technical College; "good ideas are not the monopoly of high rank."

Sir Thomas, who was reviewing officer, stressed that there was a good future for technical officers in the Royal Air Force. He presented the top Henlow awards, the Sword of Honour and the Norton Sword, to SUO B. R. C. Dowling and Tech Cdt R. A. Gill respectively.

Syerston's Royal Visit

INSTRUCTORS at No 2 Flying Training School, RAF Syerston, put on a short but attractive display when the Duchess of Kent visited the station on Wednesday of last week. It began with a formation fly-past by twelve of the station's Hunting Jet Provost T.3s; then Flt Lt Norman Clayton, who commands "C" Flight, gave a restrained but polished exhibition of solo aerobatics; and finally there was a neat round of formation manœuvres by the No 2 FTS display team, led by Flt Lt W. D. P. Jones, with Flt Lts D. J. Rowe and R. T. Stock and M. Plt J. McTavish as Nos 2, 3 and 4 respectively.

The role of No 2 FTS (which earlier this year became the first RAF flying training school to be equipped with Jet Provost 3s for *ab initio* tuition) was explained to Syerston's royal visitor by the station commander, Gp Capt G. B. Warner; and during her visit the Duchess saw the airmanship hall, where ground instruction is given in emergency and survival equipment, and inspected a line-up of aircraft, staff and students on the ASP.

The new Deputy Chief of the Air Staff, Air Marshal R. B. Lees, was also among Syerston's visitors on July 27, as were the AOC-in-C Flying Training Command, Air Marshal Sir Hugh Constantine, and the AOC No 23 Group, AVM Colin Scragg.

Air Commodore Posts

TWO air commodore appointments announced today are those of Air Cdre G. H. White as AOC the RAF Record Office at Gloucester, and Air Cdre A. A. F. Hickman is Director of Technical Training at Air Ministry. Air Cdre White was previously Air Commodore in charge of Organization at Maintenance Command headquarters, and Air Cdre Hickman has until recently been STSO at MEAF headquarters.

September 17 Aerobatics

SEVENTEEN RAF aerobatic teams will be giving displays on Battle of Britain Saturday (September 17), when 25 Royal Air Force stations are open to the public. No 111 Sqn is performing with nine Hunters at Gaydon and with five at Coltishall, then the two teams are joining up for 14-aircraft displays at Biggin Hill, Bassingbourn and Wattisham. The Fighter Command reserve aerobatic team, from No 92 Sqn (this page, last week), is appearing at Acklington, Leuchars and Kinloss; and Hunters from No 229 OCU are to give displays at St Athan and their home station, Chivenor.

Flying Training Command is putting up several teams on September 17: Vampires from the RAF College, Cranwell, and from Nos 1, 5, 7 and 8 Flying Training Schools; Provosts from No 6 and Jet Provosts from No 2 FTS and the Central Flying School; and Meteors from the RAF Flying College. Among other aerobatic performers will be Chipmunk pilots from Glasgow, Cambridge and Bristol University Air Squadrons.

Sir Hector Hetherington, Principal and Vice-Chancellor of Glasgow University, preparing for a flight in one of the Glasgow UAS Chipmunks during the squadron's recent summer camp at Thorney Island. With him is the CO, Wg Cdr D. M. Finn, who piloted the 72-year-old principal

African Airlifts

TWO big airlifts, to Kenya and to the Congo, were carried out by RAF Transport Command at the end of last month: in the former, some 700 men of the 1st Bn the Duke of Wellington's Regt and supporting units were flown from Lyneham in seven Britannias of Nos 99 and 511 Sqns; and in the latter over 1,200 Ghanian troops and 27 tons of freight and vehicles were flown to the Congo by two Comets, two Britannias and three Beverleys made available to the Ghana Government.

IN BRIEF

The Queen has approved the appointment of Viscount Brookeborough, Prime Minister of Northern Ireland, as Honorary Air Commodore of the Ulster Maritime Support Unit, RAuxAF.

RAF Watnall, Notts, which has been an air traffic control centre since 1948, is to be closed down.

The RAF ensign was hauled down for the last time at Katunayake airfield, Ceylon, on July 16, when the last RAF personnel at the base left by Hastings aircraft for Singapore.

Four Jet Provosts flown by instructors from the Central Flying School, Little Rissington, are to demonstrate formation and synchronized aerobatics at a National Air Rally being held in France at Lorient next Sunday (August 7).

The Goldfish Club, which has its headquarters at 14 South Street, Park Lane, London W1, is holding its annual general meeting at the Three Nuns Hotel (adjacent to Aldgate underground station) at 4 p.m. on Saturday, October 29, to be followed by the annual reunion dinner at 7 p.m. The hon secretary is Alan Davies.

AVM M. F. Calder, Chief of Air Staff of the RNZAF, said in Wellington on July 23 that there was no doubt about the reliability of Rolls-Royce engines fitted to Canberras supplied to the RNZAF. The RNZAF had had no hesitation in accepting reconditioned second-hand engines, since brand-new engines of the required type could not be supplied.

No 208 Sqn, RAF (formerly Naval 8), Old Comrades Association is holding its 1960 reunion at the Swiss Hotel, 53 Old Compton Street, London W1, at 6.30 p.m. on Saturday, October 22. There will be a running buffet and tickets (7s 6d each) are obtainable from the hon secretary at 18 Blacksmiths Crescent, Sompting, Sussex.

"FLIGHT" PHOTOGRAPHS

ARGOSY ASSESSMENT

by **Captain M. W. Broom**

MOST of our readers will recall Captain Broom's "Vanguard Assessment," which appeared in the issue of March 18 this year. In the present contribution he evaluates the Argosy from an airline pilot's point of view. The author is a BEA pilot and is also chairman of the technical committee of the British Air Line Pilots Association, but the views he expresses here are his own and do not necessarily represent those of either of these two organizations.

ONCE again I had to try my luck with the weather, this time when I made arrangements to visit Bitteswell, the home of Armstrong Whitworth's Argosy; but my choice of dates was not an unqualified success for, as those who keep records will recall, July 13 and 14 produced a mixed bag of showers and fine periods. The purpose of my visit was to have a flight in this latest addition to Britain's list of civil aircraft, due to finish its certification tests in the very near future.

I was not entirely unfamiliar with the Argosy, having already seen it several times; in fact my connections, though slight, were sufficient to give me a bias towards it. I had first met Eric Franklin, the chief test pilot, when his firm had sought the co-operation of the British Airline Pilots Association concerning the design of the flight deck. Here was one of those rare cases of an aircraft constructor embarking on a new civil project and seeking the views of those who would be most intimately concerned in its operation. Such co-operation should produce worthwhile results; we shall know for certain when the aircraft comes into service.

Too heavily committed himself, Eric Franklin had signified that he was passing me over to the very capable guidance of one of his test pilots, C. W. Simpson, known to all as George. After a frustrating journey behind innumerable heavy lorries, I arrived at the peaceful open spaces of Bitteswell on the Wednesday morning, and before very long I was busy learning about the Argosy.

George, being concerned with the compiling of the Pilots' Notes, was an ideal choice to give me the broad outlines of all the various systems and their functions. We spent the afternoon having a good look over G-APVH, the fifth aircraft and the one in which I was to have my flight in the following day. Whereas one can step into the aircraft without steps, if one's legs are long, it is somewhat novel to most of us to climb a ladder to the "office"; but it is worth the climb, as the flight deck is a happy compromise between spaciousness and compactness; I think this is because the general design is clean and orderly, without afterthought additions. Here again is a flight deck which starts its life scrupulously clean and tidy; and, as it will be their working environment, the pilots have a right to expect the same standards of cleanliness as do other sedentary workers; so we can but hope it will remain uncluttered. The radio operator's position is situated at the rear of the flight deck, with a compact radio crate against the rear wall, so there is room to move about between this position and the pilots' seats without the hazard of equipment being accidentally knocked when the crew are moving about in flight. Even at the pilots' position, and despite the usual amount of equipment which in these days must be within the reach of both pilots, there is room to move in and out of the seats safely. Neither pilot is jammed into his operating area like the last sardine into the tin.

Seated in the captain's seat I was able to relate the morning's discussion to the various parts of the flight deck—the anti-icing controls on the roof panel above the captain, the air conditioning and pressurizing controls above the first officer, and between these two the radio controls and some of the "oddments" such as test switches, navigation and landing lamp controls, door warning lights and pitot switches.

On the left side of his panel the first officer has the fuel control panel, but with the simple system used and the clear line-diagram of the panel layout his task is simple enough. The system used is basically a four-tank one, and with each "tank" of 825 Imp gal capacity and feeding one engine, this means that under normal conditions neither cross-feeding between sides nor engines is required; and incorporation of doll's-eye indicators in the line diagram makes the positions of the l.p. and cross-feed cocks immediately obvious.

The functioning of the d.c. electrical supplies is also easily followed by line diagrams, the generator panel being on the 1st officer's console. The system itself is simple, with the generators on Nos 1 and 2 engines feeding bus-bar A, Nos 3 and 4 supplying bus-bar C and the aircraft or ground battery supply feeding bus-bar B; A and C are connected to B through reverse-current circuit breakers; and a warning light, coupled to the alert-warning system, comes up on the panel should a bus-bar split occur, either through a failure or by the operation of the emergency switches on the centre instrument panel coaming.

Altogether George and I spent some two hours on the flight deck and this helped me considerably to settle down on the next day's trip. With so much of my piloting life spent on night flying I would have liked to assess the lighting of the flight deck, but this I was obviously unable to do by day. I know that considerable effort has been devoted to keeping the extraneous light down to a minimum by using pillar lights on all the instruments. Though some of the roof panel switches are lit by etched plastic I think that the roof-systems panels could profitably be similarly treated; on G-APVH they are not.

The next day started fine but by the time we had finished the pre-flight briefing the cumulus was building up and it promised to be a bit bumpy. After the usual long list of pre-flight checks we were ready to start and I took the opportunity to adjust my seating position. In the short time available I found the seat most comfortable; it is adjustable for reach and height and the rake of the back-rest, and with the adjustable arm-rests and clear floor space in front gives plenty of room for movement and relaxation in flight. The only adjustment to the controls is to the rudder pedals, which can be varied in rake as well as through the usual distance from the seat.

Start-up is by standard Dart engine procedure, the start panel (at the rear of the starboard console) containing the master switch, engine selector, starter button and current-flow light. Having called for chocks away and obtained taxi clearance, one seemed to need a fair amount of engine to start the aircraft moving, but as the r.p.m. gauges were winding away at an unfamiliar rate the

"George Simpson . . . was an ideal choice to give me the broad outlines of all the various systems and their functions"

ARGOSY ASSESSMENT . . .

actual power was probably not so very great; I was also busy trying to steer. The nosewheel steering I found to be the hardest part of the aircraft with which to become familiar; in fact, in the short time I spent taxying, I did not really master it. Transmission is electrical from the steering wheel to the nosewheel steering jacks, which themselves are hydraulically operated. To prevent shimmy, both nosewheels are mounted on a solid axle, so that the rate of movement is not very high and fairly constant; the effect is to give a considerable response lag if too much or too rapid movement of the steering wheel is made. That the system is satisfactory is proved by watching the test pilots handling the aircraft, but it seemed to me that considerable practice and care is needed to become familiar with it. Tests are still in progress on the system, and probably an improvement in both response and rate of turning will be achieved. Both the nose unit and the steering wheel are self-centring; the latter incorporates an arming device to energize the electric circuits.

The brakes are very effective and of considerable value for taxying, probably owing to the very wide track. They are powered from the main hydraulics, there being two separate systems available, one for normal anti-skid operation and one for emergency use. The pressure in each accumulator and brake system is shown on two gauges on the lower left corner of the captain's instrument panel (which constitutes the hydraulic panel on the flight deck).

By now we were ready for take-off, and with the weight at 70,000lb our V_1 was 91kt and V_2 100kt. With the rudders becoming effective by 80kt and the speed rapidly building up we were very soon at V_1 and, by giving my usual gentle pull for the benefit of old ladies down-the-back, V_2 was passed and gone by the time we left the ground. We climbed steadily away with speed building up to 135kt; and during all this there was little or no trim change, even when undercarriage and flaps were retracted—though I may possibly have made minor adjustments without being aware of it. At the best climb gradient of 132kt the angle seemed a bit steep for normal passenger use, and around 155kt gave a better floor angle without any apparent loss in rate of climb. As we disappeared into cloud at 2,500ft climbing through Amber 1 (under radar!) I was soon able to test the instrument qualities of the aircraft and these were most pleasant. Whereas on the ground the controls seem stiff and heavy, in the air forces are light and the controls responsive; the trimmers are also effective and without any sponginess in operation. We were climbing at power settings of 14,200 r.p.m. and 740° tailpipe gas temperature; this gave us approximately 1,200ft/min, so that we soon found a clear channel at 10,000ft between the build-ups over Upper Heyford, and we patrolled up and down in this area for the best part of the flight.

Levelling off at FL 100 I tested the response of the controls at cruising speed. With 210kt indicated, and remembering the ARB requirement, I found the ailerons surprisingly light even when rolling rapidly to 30° on either side. The light controls seem to be a pleasant feature of the Argosy, for when I later tried the effect of the rudder I found the same response and lack of weight. This was when the critical engine (No 4) was feathered. With take-off flap and full throttle on the other three, speed was reduced to 90kt, at which point the stick-shaker operated but I found I still had plenty of rudder movement left, and—more important—plenty of "push" left in my leg. Minimum-control speed is listed as 80kt, so there should indeed be few occasions when an Argosy pilot finds himself short of rudder movement.

With such light controls it is not surprising that handling on three engines presents no problems. From force of habit when "straining" on three, I found I was over-correcting, and a glance at the trim settings showed I was needing only a very small proportion of the total available. Moreover, the aircraft felt quite docile weaving about at 130kt, so that circuits on three should be perfectly easy.

In order to feel the approach to the stall, listed as 70kt at this weight, undercarriage and flaps were lowered. The latter are double-slotted, and "gated" at take-off (12°), approach (24°) and landing (40°); their operation in flight produces only small trim changes, even the selection of the 40° position at 180kt producing only a small float-up easily controlled with the elevators. There are three flap sections on each side, operated by chain and sprocket from torsion bars joined in the centre-section at the hydraulic motor; there is no special provision to prevent asymmetric operation in the event of some failure, but reliance is placed in the fact that the system is thoroughly proven.

Both undercarriage and flaps are hydraulically operated from conventional flight-deck controls. The undercarriage has a push-button control on the lower central panel, with a neat indicator above it. The flaps are operated by a lever beside the captain; this is a mechanical linkage to a hydraulic selector back in the wing, and there is a corresponding position indicator above that for the undercarriage. The main hydraulic system has pumps on engines 1, 2 and 3. It takes its fluid from the main reservoir in the port boom to pressurize the three accumulators in the hydraulic bay in the port side of the fuselage. Working pressures are 2,500 to 3,500lb/sq in and, apart from gauges in the bay itself, there are three pressure gauges on the flight deck hydraulic panel, a small one showing main system pressure and the two brake-system gauges already described; in addition on this panel are three failure indicators, one for each engine-driven pump. The main system serves the normal undercarriage and flap selectors, brakes and nosewheel steering, but in the event of failure there is a stand-by system for selecting undercarriage down, and—at a reduced rate—any degree of flap. This stand-by system operates the freight doors, and is situated under the main compartment flooring. When required for emergency undercarriage or flap use, the operation of the appropriate switch on the forward left side of the central pedestal automatically disconnects the door system, and fluid is electrically pumped either into the undercarriage-down lines—which releases the up-locks and engages the down-locks after a free fall—or to the flap motor. Each freight door also has a separate hand-pump system for operating the locks.

Having completed the few tests I had set we contacted Bitteswell radar to get us down through Amber 1. By this time I was familiar with the feel of the throttles, which are well placed, smooth to use and quite responsive to small movements, with very little "dead" movement. I was also getting used to the r.p.m. gauges, which, having two hands, are very sensitive, the larger making one complete revolution per 1,000 r.p.m. This means that revs can be very accurately set up, but for this type of engine I would say that a less-sensitive instrument—say, one revolution of the large hand per 10,000 r.p.m.—is adequate, especially as automatic synchronization is fitted. However, the engine instrument layout is tidy and easy to read, all the instruments being the same size. The rest of the engine controls are logically grouped on the central pedestal—as required by BALPA—in the order from front to rear of the feathering and fire drills (i.e., h-p. cock, fire-warning light, feather switch, l-p. cock, and two-shot fire extinguisher). The relight switches are beside the h-p. cocks, and the feather-motor current lights in front of them.

De-icing Operation

By this time there were heavy showers about, and as we had to descend through them a check of the various anti-icing systems was made. The panel for these is above the captain and consists of five blocks—windscreen, fuel filter, wing leading edges, tail unit and engines—but there is nothing fancy about the systems, all being well-tried in operation on other aircraft. The three front windscreen panels are heated electrically, the power being supplied by the alternator on No 1 engine and controlled thermostatically according to the setting of an OFF-½-FULL selector switch; should No 1 engine fail there is a change-over switch which taps the alternator first on No 4 and then on No 3. The fuel filters are de-iced by the usual Dart method of bleeding hot air from the compressor and, though the manual-switch facility is still available in conjunction with the warning light, automatic operation is available which lifts a further load off the pilots. The wing anti-icing will be familiar to Viscount pilots; a heat exchanger in the jetpipe of each inboard engine heats ram air which is then ducted along the leading edges. The system works off either or both engines, and flight deck indications are two overheat warning lights, coupled into the alert warning system, plus a temperature gauge for each wing. The tail unit, however, is heated by Napier electric Spraymats, obtaining its power from all four alternators; by mixing the various heating pads, some continuously heated and others fed through cyclic time-switches, there should always be sufficient protection. The alternators also give ice protection to their respective engines, the usual HEAVY-OFF-LIGHT switch and operating light being provided for each powerplant. With all these loads on the alternators a certain amount of information as to their condition is desirable. Each is therefore protected by a RUN-KILL switch and warning lights to show undervolt earth warning, overheat or failure of the alternator. Incidentally, the operation of a KILL switch off-loads that section of the tail unit normally supplied and passes it to the

corresponding alternator on the opposite side of the aircraft.

Bitteswell directed us by their radar round the build-ups and down under Amber 1 on to a right-hand downwind for Runway 22 —the left-hand downwind being occupied by a cu-nim. With its smooth and pleasant control the Argosy presents no problems around the circuit, so that I was unconcerned about the speed; anything from 120 to 150kt feels the same, and due to the position of the flight deck there is no noise when the undercarriage is down in flight. Radar brought us in to within 2 miles, and I found no difficulty maintaining a steady descent at 120kt. Reducing speed to 115kt across the threshold I did not succeed in the gentle touch-down we all strive for. This I think was due to the different attitude to which I am accustomed, the greater height being coupled with more ground and less sky visible. However, once we were firmly down George brought in the ground fine pitch, as shown by the propeller warning lights on the forward end of the pedestal; the arming levers for ground fine pitch are between both Nos 2 and 3 throttles.

This all-important question of visibility—what is it like? The main windscreens are some distance in front of the instrument panels; I was not conscious of any obstruction by the frames and downward vision is particularly good. Care has been taken to get the frames of reference as nearly symmetrical as possible, and with an excellent horizontal glare shield the bad-visibility approach case is well catered for. It is careful thought and design such as this which can do so much to aid pilots at most stages of flight, but particularly under critical conditions is it important to alleviate the battle in the pilot's subconscious between optical and physiological illusions, and what his instruments and experience tell him are the actual conditions at the time. It is lack of attention to the details of design which have in the past (and will in the future) overload the pilot at times of high stress, leading him into errors which cause the accidents invariably classed as "pilot error."

Altogether we were away from the tarmac for one hour, and by the end of that time I was beginning to feel quite at ease and confident that, if asked, I could take the Argosy down some familiar route. This is not boasting, but indicative of the ease of handling of the aircraft, and I see no reason why, once the systems are appreciated, any pilot converting to the type should have any difficulty. Perhaps the ease with which I felt at home was due to the layout of the flight deck, and systems with which in principle I was familiar.

The only systems under the pilot's control I have not mentioned are the a.c. supply and air-conditioning; both these are above the first officer. There are three inverters, one fed from each bus-bar and controlled by three-position switches; in the event of an inverter failure the appropriate warning light, coupled into the Alert warning system, comes on, and by switching from Normal to Emergency the load is shed on to the two remaining inverters. The pressurization system is largely automatic, being controlled by the pressure controller through the relevant selections of QNH and height on the airport altitude selector. Air from the blowers on engines 1, 2 and 4 is controlled by spill-valves "energized" through individual master switches and positioned in unison by operation of an inching switch. In conjunction with this last-mentioned switch, labelled Air Supply, there is an indicator which gives the position of No 1 spill-valve. There is also control over cabin temperature.

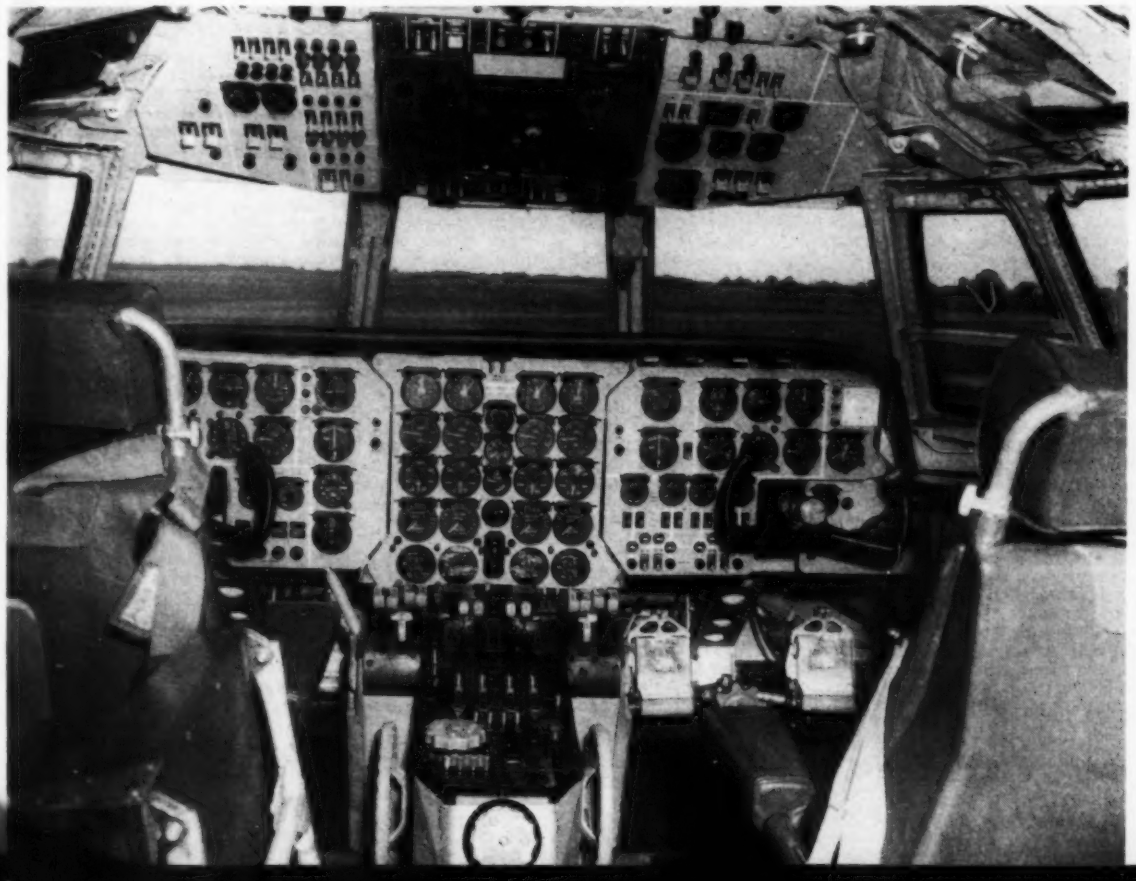
Finally, for the occasion which one hopes will never occur: emergency exits. Knowing how small a space some pilots have exitted through, I expect the fairly large d.v. panels are big enough to climb through, but there is also a large escape hatch at the rear of the flight deck, equipped with a rope (this hatch permits a good view of the wings and tail unit for visual inspection on the ground). In the main compartment "downstairs" there is, apart from the passenger door in the port side, an emergency door opposite in the starboard wall; also, four of the windows can be pulled in to give quite generous openings.

To sum up then, the attempt to produce a flight deck in which the pilots can work efficiently without undue strain has been largely successful, and this without large expenditure on super-sophisticated schemes. I was, however, conscious at times during the almost continuous use of the intercom that the noise level was fairly high; this no doubt is the result of the bluff design required by the basic concept, but even so any reduction in this noise level will be beneficial. Considering the solid and lumbering look of the Argosy on the ground the handling is quite surprisingly good, and this on a machine which caters economically for operators without overful purses. Though no machine goes through life without its troubles, the use of well-tried systems, components and engines should give a trouble-free career to the Argosy.

In giving this thumb-nail sketch of the Argosy, I have put a large aircraft into a small space, and with concentration on odd points during one short flight my comments must be taken as being first impressions only, although admittedly favourable ones.

In conclusion, I must express my sincerest thanks to Armstrong Whitworth for permitting my flight, and also to Eric Franklin, George Simpson and the others for the welcome, hospitality and co-operation given me to make this a memorable visit.

"Seated in the captain's seat I was able to relate the morning's discussion to the various parts of the flight deck—the anti-icing controls on the roof panel above the captain, the air conditioning and pressurizing controls above the first officer and between these two the radio controls and not too many 'oddments' such as test switches, navigation and landing lamp controls, door warning lights and pitot switches"



MORANE SAULNIER RALLYE in the Air

BY MARK LAMBERT

No 131 of the Series

"Flight" photograph

EVERY now and then someone designs the "ideal light aircraft," just as the motor industry occasionally produces something like the Fiat 600 or the Mini-Minor. But few of the aircraft have met with success, either because the project failed commercially or because the aircraft turned out to be less "ideal" than intended. The Sipa Coccinelle is a prime example of the commercial failure—or rather commercial non-arrival—but the Morane Saulnier Rallye looks like being a definite success.

Like Sipa some years ago, Morane have properly conceived the Rallye as a complete system. Having developed a most intriguing aerodynamic vehicle, originally entered for the now defunct French Government competition for an *aéronef de grande vulgarisation* or every man's aircraft, Morane have laid down a production batch of 250, the first of which is to emerge early next year and the later machines are to be completed at the rate of three per working day. The all-metal structure has been specially designed for ease and cheapness of production and spare parts prices are to be remarkably low—£3 for one of the four slat sections; £135 for a complete wing panel; £5 12s for the surface which forms the rudder or half the elevator, and so on. The Rallye was to have an alternative tailwheel or nosewheel undercarriage—changed from one to the other in 20min—but the nosewheel is now to be standard. The aircraft will be a three-seater with the possibility of four seats with no baggage, reduced fuel and on condition that the rear two people weigh less than 242lb together. Useful load is 700lb of which the full fuel load takes 158lb. Range is 500 miles.

The Rallye is to be offered in three versions, the Club powered either by a Continental 90 h.p. or 100 h.p. engine and the Super with a Continental 145 h.p. engine. All have fixed-pitch Ratier metal propellers as standard. Radiostal VHF and DF radios are optional as is shoulder harness, because the Rallye is aerobatic with one occupant—the French pilot in fact made several fast rolls when I flew with him.

The Rallye agency in Britain is being negotiated by the London Aeroplane Club at Panshanger and the price of the 90 h.p. version, duty paid in Britain, will be well under £3,000. With the quite special handling characteristics, cheapness and economy, the Rallye can fairly be regarded as a replacement for virtually any two- or three-seater now flying in this country.

At first sight, the Rallye is not prepossessing, with its chunky fuselage and tail, full-span slats and liberal use of fluted skin panels. But it is business-like and obviously of Morane lineage. All trailing edges are blunted and the windscreen is of the traditional wrap-round form giving exceptionally good visibility beside the nose. The two pilots also sit almost level with the leading-edge so that map-reading should be child's play.

The large, full-span slats are restrained by an air damper; and the flaps and ailerons are all of the same section and chord. Their shrouds and external hinge brackets are of different shape and size and geared tabs are fitted to each aileron. The main wing structure is a fairly narrow torsion box containing a 50 litre fuel tank each side, both tanks feeding through a single on/off cock and an engine-driven fuel pump. To meet CAR.3 requirements, an electric standby fuel pump is also provided. Fuel is thus on the c.g. When first seen at the Paris Show in 1959, the Rallye had end-plate wing-tips, but it now has large tip fairings which project well ahead of the leading-edge when the slats are in. The rear fuselage is a cylindrical, tapered semi-monocoque carrying a large dorsal fin and rail for the canopy and the fin which also carries the fixed-incidence tailplane. The elevators are continuous and ride free above the fuselage and aft of the rudder and carry a single slab-like trim tab on their trailing-edge. Dynamic pressure is sensed at a stumpy probe under the starboard wing and static pressure at a flush port on each side of the rear fuselage. The cabin rear bulkhead can be zipped open to accommodate fishing rods or skis.

All three undercarriage legs have similar oleo-pneumatic shock absorbers, with levered suspension and streamline fairings on the main wheels and a free-castoring mounting for the nosewheel. The main legs are attached by a casting and four bolts to the under-surface of the wing and the nose leg has a single attachment to the firewall and two small struts just inside the fuselage. The engine cowlings unclip quickly to reveal the powerplant and there is plenty of room to work in. All exhaust pipes are collected into a single ejector pipe which also provides a hot-air jacket for cabin heating. Alternatively a good rush of cool air may be let in and the canopy can also be left an inch open to give tropical cooling in the air. The canopy tends to close under airstream forces.

A stout footstep either side makes it easy to climb up on to the wing torsion box, although the flaps and fairing must be avoided. The canopy slides far enough back to allow someone to get into the back while both front seats are occupied. Individual front seats are softly upholstered and separated by the flap and trimmer quadrant and there is just enough elbow room if the canopy sill is used as an arm rest. In production aircraft, the flap lever will be moved farther down and the cockpit widened by two inches to give comfortable elbow room. The bench seat in the rear is only a few inches wide, little more than a ledge, but production cabins will be 7in longer to provide a reasonable seat. The fin is also to be swept back slightly so that the Rallye will look very nearly pretty. Personally, I think that the advantages of cheapness and excellent handling fully compensate for a rather chunky appearance. After all, one's aircraft is a vehicle, not a mantelpiece ornament. The cabin is lined in plastic material in a choice of bright colours.

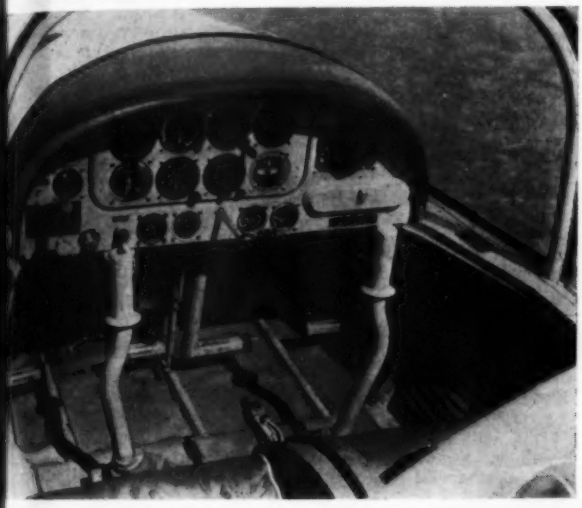
Standard instruments will include engine gauges, pressure instruments and compass, but the prototype comfortably accommodated full blind-flying panel, and certain additional engine instruments, as well as the Radiostal VHF/VOR. The controls include master and generator switches, carburettor hot air, mixture and priming plungers and a rotary magneto switch with key, all positioned for the left seat. The pendant rudder pedals were fashioned from hefty L-shaped tubes and the toe brakes were big and easy to use, the parking setting being applied by pulling a lever at each pedal to snub the cable with an eccentric. It looked simple, strong and effective and was very simple to release. Although the throttles were duplicated, the brakes were not.

I give the Rallye full marks for visibility. The coaming in the middle is just below eye level, but that wrap-round Morane windscreen is a honey. I could also see the whole tail and the narrow wings were very little in the way. With the slats extended, one can see quite a bit between wing and slat if necessary. With its extensions, the cabin will be very comfortable in front and just about reasonable behind, but I feel the canopy could be a fraction higher. I did not quite touch it when it was closed, but it cracked my head a stout blow when the pilot pulled it shut unexpectedly on the ground.

My first flight in the Rallye was as Leboucher's passenger during air-to-air photography. He made the take-off run hands-off and we climbed very steeply after unsticking at about 85km/hr (53 m.p.h.). After we had danced around with the Gemini Leboucher showed me some Rallye-isms which are pretty spectacular. With the aircraft trimmed hands-off in the climb at 95km/hr, cruising at 160km/hr and with everything out and down at about 100km/hr, he whacked the stick—and I mean whacked it—in all four directions. The Rallye only jolted and kept flying in its trimmed attitude. Climbing hands-off with full flap he shot the flaps in and the Rallye simply jerked and continued to climb with the nose very gradually rising. He pulled it up at about 45° with a lot of power, brought it virtually to the stall and crossed the controls hard. We just yawed hard, but kept

flying and climbing. He held a heading at cruising speed with the rudder alone, using his hands to fiddle with an imaginary map. Finally, he made me hold the stick hard back, with flaps down and power off, and watch the *déscente parachutale* at 1,000ft/min and 44 m.p.h., the fuselage level and all set for a very heavy landing. Then he approached at a normal 105km/hr (65 m.p.h.), and put us sweetly down on all three wheels to stop with brakes in much less than 100yd. Later we were to land deliberately with brakes hard on—they designed the Rallye for that, too. The airframe is stressed for 3.3g positive acceleration at the VNE of 156 m.p.h., the ultimate factor being 6.6g.

The impression I had after watching the Rallye being really maltreated was that it was obviously extremely stable, crisply manœuvrable and quite exceptionally and genuinely forgiving. Many aircraft can be made to seem almost viceless, but most of them will ultimately bite quite hard when their docility finally runs out. I got the impression that the Rallye would have to be pushed a great deal further and would even then react in a more gentlemanly fashion. Largely this can be ascribed to a cleverly limited elevator effectiveness and to those enormous slats. If one slows down in level flight, the elevator is hard up at the point of a very gentle incipient stall with just the faintest aerodynamic buffet. From there, the aircraft will simply enter its *déscente parachutale* without dropping a wing or pitching. If you zoom up into the stall, the flow breaks down in the same way and the nose



"Flight" photograph

The cockpit is neatly arranged with a panel containing full blind-flying instruments, which will be optional in production aircraft. The Radiostal radio is at far right. Note the ample toe-brakes with their parking handles on the pendant rudder pedals. Flap and trim levers are between the seats

will drop to a point where airspeed is regained and elevator once again becomes effective. If the stick is still kept hard back, the Rallye will go downstairs, rather like a Piper Super Cub, but the remarkable point is that the phugoid descent will then stabilize to the level descent, whereas the Super Cub and many aircraft like it will wind up the phugoids until they reach a proper juddering stall with a slight wing drop.

I think the Rallye undercarriage might possibly suffer if it was dropped straight on to the ground with the stick hard back, but I was not prepared to try it. Equally, I am fairly certain that the occupants would survive, perched as they are over the wing which continues through the fuselage. Anyone can kill himself in an aeroplane if he wants to; but the Rallye will stay with him for longer, I think, than any other aircraft I have known. The trouble is that someone will eventually try to reach the limits, and I only hope he does it after the Rallye has established its deserved good reputation. Nothing kills new aircraft (or a pilot) so quickly as damn-foolishness.

Now I have given the impression of one of those ultra-safe aeroplanes which usually are very unexciting to fly. But the Rallye is much better than that. It retains the distinctive Morane handling—precise and crisp, but with a feel which I can only describe as slightly dead. I immediately recognized the feel of the Paris which I greatly admire as a pilot's aeroplane. The Rallye prototype actually had slight friction in the rudder circuit and the inertia of the elevator could be felt when waggling the control on the ground. Aileron friction was practically non-existent.

On the ground, the aircraft was steered with brakes alone and these were adjusted so that they could be fully applied before landing on tarmac and would then skid the wheels only slightly. Directional control was surprisingly good for such an arrangement and very tight turns were easy. Retardation was adequate and the suspension gave a smooth and quiet ride even on very rough grass. Take-off power produced a good deal of noise, with a distinctive popping from the exhaust. Soundproofing for cruising flight might also bear improvement.

We left the ground in 11.5sec with two occupants and 12.3sec with three. At 2,400 r.p.m. (maximum continuous is 2,475 r.p.m.) we climbed from 960ft a.s.l. to 1,625ft in 70sec, which is 570ft/min. At 1,600ft and 2,400 r.p.m. we reached 165km/hr, which would probably have trued out at 103 m.p.h. At about 155 km/hr I measured the rate of roll as 120° in 3sec, but Leboucher achieved the same in 2.3sec, equal to 52°/sec from a stable bank. I rolled

MORANE SAULNIER MS.880 RALLYE

(Continental 90 h.p., 100 h.p. or 145 h.p. engines)

Span, 31ft 4in; length, 22ft 6in; wing area, 132.4 sq ft; aspect ratio, 7.57; empty weight, 1,003lb; max gross weight, 1,708lb.

Performance with 90 h.p. (figures in brackets for 145 h.p.): max speed, 122 m.p.h. (143 m.p.h.); cruising speed at 2,600ft, 106 m.p.h. (130 m.p.h.); rate of climb, 512ft/min (1,063ft/min); take-off run on grass, 722ft (394ft); landing run, 295ft (328ft); range, 500 miles (684 miles with extended wing-tanks).

without rudder assistance. Morane say that this rate of roll remains practically constant over the speed range. Quite large control deflections were necessary to overcome pronounced stability, but the measured rate of roll, which included acceleration from a stabilized bank, clearly illustrated the very crisp manœuvrability which is useful in rough air and for aerobatics.

An important feature of the Rallye is its near indifference to configuration changes. The slats came smoothly out at about 105km/hr (63 m.p.h.) and went in again at about 150km/hr unless the nose was tipped sharply down to push them in. Maximum flap speed was 81 m.p.h. and trim change could be countered with half-aft trim, power on. The nose went down somewhat but stability remained marked. With power off, full aft trim did not quite relieve stick load at the approach speed of 62 m.p.h., but the rate of descent of about 1,000ft/min gave a remarkably steep gradient. The round-out was light and easy and the aircraft settled on to all three wheels after a very short float. The landing run could be ridiculously short. We landed on tarmac with three

The Rallye at about 60 m.p.h. with slats fully out and large flaps down to their full 30° setting. Attitude is level and visibility excellent

"Flight" photograph

occupants, with the brakes hard on, and stopped almost between two of Yeadon's runway lights. I had one brake on harder than the other, but the resultant swing was almost instantly checked. In about 400yd, from a point where I thought we must overshoot the runway, we descended from 300ft and stopped, the ground-run occupying about 50yd.

With its all-metal structure, short-field performance, docility and manœuvrability, the Rallye makes a very attractive three-seater for club flying or touring. With the 145 h.p. engine it will go like a bomb on take-off and cruise appreciably faster. Its price is attractive and large-scale production should provide spares backing. I think it is the most attractive light aircraft yet to be imported into Britain and makes more sense than any other for the private pilot or club. It is tough enough for training, but some might consider it too docile.

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. The names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

Getting Aboard the Supersonic Airliner

THE expansion of commercial air travel has taken place largely through extended technical effort applied to the solution of a problem which has never been re-stated since the day of the first scheduled passenger flight. The approach has always been that we must design an aircraft which is able to arrive at a point on the ground that is convenient to the fixed passenger or cargo facilities. This basic requirement has been applied to every passenger aircraft design that has been evolved in the past and seems to be inherent in specifications for aircraft of the future.

The concept of the aircraft meeting the passenger on his own ground remains unchallenged—and rightly so, when one considers the economics of operating subsonic aeroplanes. We have observed, however, that with larger aircraft requiring high utilization there has been a mild shift toward the idea of moving the passenger very short distances to loading ramps away from main buildings with a thought toward lessening aircraft-manœuvre problems and ground turn-around time.

Our next generation of supersonic aircraft will have all the problems of subsonic aircraft operation magnified considerably. It is a well-known fact that a tremendous step forward in speed must be attained in order to reach the same flight efficiency at which present Mach 0.85 aircraft operate. This new minimum required for the supersonic transport is in the order of three times the speed of sound. When we consider the cost to design an aircraft to operate over the range from "stopped for loading" to "Mach 3 cruise," we are forced to reconsider the whole situation from basic principles.

My suggestion is that we airlift the passengers in a turboprop aircraft to a rendezvous with a supersonic aircraft in flight. An attachment is made and the full complement of passengers in the low-speed aircraft would then embark on the supersonic airliner through a suitable pressurized tube. Fresh crew transfers could also be effected and in-flight refuelling might be considered as a simultaneous operation.

Such a system in operation would lead to a simplification of the design of a supersonic airliner, increasing its reliability and payload and, in addition, would obviate the necessity for construction of still longer runways. The nature of the aircraft suggests that we might consider operating all these machines from one location, for example, California. This location would serve only as an overhaul base. The aircraft would remain airborne continuously between overhaul intervals, with routine inspection and maintenance carried out in flight. This arrangement would take full advantage of the supersonic airliner by virtue of operating at design-point conditions almost constantly. Zero-power landing and boosted take-off at the overhaul base would occur infrequently.

This approach appears to be within the present ability of the industry, but what of the economics? This is a difficult question to answer, but we can observe that, by this method, we are increasing the utilization and productivity of the highest single capital-cost item in our transport system. This feature alone may be sufficient to justify a proposal for in-flight passenger transfers.

Winnipeg HENRY TUISKU NORTH,
Assistant Professor, Dept. of Mechanical Engineering, University of Manitoba

Noise for Posterity

From Air Cdre A. H. Wheeler, CBE, MA, FRAeS

READERS of *Flight* will scarcely need reminding that aircraft noise is at a discount. Members of the public living near large airports are woken up by it and in their turn wake up Ministers to tell them how unpleasant it is to be awakened from their—at one time—dreamless slumbers. Ministers and officials make pronouncements that in future the rules regarding aircraft noise will be enforced, admitting by implication that these scientifically thought out rules have, in the past, been ignored.

One would assume, therefore, that *selling* aircraft noise would be as near impossible as anything can be. Yet it has very recently been done. The Shuttleworth Trust have just come to an agreement with the BBC whereby the noise from historic aeroplanes in the Shuttleworth Collection will be recorded for all time and perhaps broadcast from time to time.

Thus the noise has not only been sold but may be re-sold to delight the ears of the young who have never heard it and the old who, nostalgically, want to hear it again. These listeners will soon be able to hear the uneven hiccough of the fan-type Anzani engine which Blériot used when he first flew the English Channel. Although this engine has three cylinders it always manages to sound as though it is only firing on one. The later Y-type Anzani fitted to the 1911 Deperdussin gives a slightly more reassuring noise, but even with this in front of him the modern pilot would hesitate even to try to leave the ground.

Advancing only one year in time there is the happy, even, purr of the little 50 h.p. Gnome engine fitted to the oldest British aeroplane still flying—the Blackburn Monoplane of 1912. The brilliant and revolutionary design of the Frenchman Seguin, it was this engine that first made flying a reasonably practical proposition.

By 1916 the Sopwith Pup with its 80 h.p. le Rhone—still in full flying order in the Collection—was heard in large numbers in the skies of the Western Front: it can still be heard today and doubtless will be in some radio programme. This is as delightful to the ears as it is to fly behind. It was one of the smoothest aero engines ever built before Whittle produced the jet. All rotary engines had this virtue, but as they became more powerful some of the smoothness was lost.

Coming to more modern designs, but still in the World War I period, there is the Hispano eight-cylinder (two banks of four) developing 200 h.p. and very similar in layout to many modern car engines. With its almost open exhaust it makes a staccato sound almost like tearing calico. Then the world-famous Rolls-Royce Falcon vee-twelve engine developing 275 h.p. with nearly twice as many parts as any other contemporary engine and (still) nearly twice as reliable; a quieter and more reassuring noise comes from the Falcon.

Although larger multi-engined aeroplanes of that date are no longer preserved in flying order it will be possible, by ingenious means, to simulate the noise of such famous aeroplanes as the twin-engined Vickers Vimy in which Alcock and Brown made the first direct flight across the Atlantic. This can be done by recording the noise of the Falcon (very similar to the later Rolls-Royce Eagle engine) running at very slightly varying speeds and then superimposing one set of recordings on another, thus reproducing the "beat" as twin engines run in and out of phase.

Perhaps in years to come other listeners, yet unborn, will demand to hear, and delight in, the recorded noise of a four-jet airliner taking off from London Airport; but just for the present the public feel they can do much better without it.

Twyford, Berks ALLEN WHEELER

Defenceless?

WHEN the Government White Paper on Defence was passed in April of 1957 it was announced that the Royal Air Force could no longer defend the British Isles in their entirety. Only the V-bomber and Thor rocket bases could be successfully guarded in the event of war. Now that Mr Duncan Sandys is no longer Minister of Defence, cannot something be done as regards re-establishing the air defence of our cities and countryside? After all, we are told that the human being is still the most important object on this planet. I think I would be right in assuming that America and Russia—both nuclear powers—still maintain aerial defences over their cities and towns. The question arises: what about us? The twentieth anniversary of the greatest battle of history is near at hand—I refer, of course, to the Battle of Britain, when one thousand British boys smashed the Luftwaffe's attempt to smash us. How can we remember the men of 1940 with reverence, when their descendants can't remember us in 1960?

London NW6 ROBERT CARR

FORTHCOMING EVENTS

Aug. 7-17. Bulgarian Aero Club: World Parachuting Championships, Mousatcheve, near Sofia.
Aug. 10. Kronfeld Club: MTCA Air-miss film.
Aug. 14. Elstree Flying Club: Tea Patrol.
Aug. 17. Kronfeld Club: Talk on National Gliding Week.
Aug. 20-21. Pescara Aero Club Rally.
Aug. 21. Colman Aero Club: Alsace Wine Rally.
Aug. 27. Luton Flying Club Display, Luton Airport.
Aug. 28. Oxford Aeroplane Club At Home, Kidlington.
Aug. 28-Sept. 4. Czech Aero Club: World Aerobatic Championships.
Sept. 3-5. French and Savoy Aero Clubs: International Centenary Rally, Aix-les-Bains.
Sept. 4. Wolverhampton Aero Club At Home.
Sept. 5-11. SBAC Display and Exhibition, Farnborough.
Sept. 8-12. AGARD and Instituto Lombardo di Scienze e Lettere: Seminar on Propulsion for Astronautics, Varenna.
Sept. 9-12. Popular Flying Association Rally, Cranfield.
Sept. 11. International Landing Contest, St Nicholas Maes.
Sept. 12-16. Institute of the Aeronautical Sciences: Second International Congress, Zurich.
Sept. 12-18. Battle of Britain Week.
Sept. 25. Milan Aero Club: Helicopter Rally.
Sept. 26-Oct. 1. AGARD Structures and Materials Panel Meeting, Athens.